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APOLLO MONTHLY PROGRESS REPORT (U)

NAS9-150

May 1, 1964

Paragraph 8.1, Exhibit 1

Report Period

March 16 to April 15, 1964

[redacted]

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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ILLUSTRATIONS

TABLES

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PROGRAM MANAGEMENT

STATUS SUMMARY

Boilerplate 13 was mated to the SA-6 launch vehicle at Kennedy Spacecraft Center, and boilerplate 12 was mated to the Little Joe II booster at WSMR. These operations are described in detail and illustrated in the Operations section of this report.

The service module and adapter for boilerplate 26 were shipped to Marshall Spaceflight Center during the report period for installation of micrometeoroid measurement instrumentation.

Four parachute drop tests were conducted using the cylindrical bomb test vehicle, and one parachute drop test was performed using boilerplate 19. The success of the boilerplate drop removed a constraint from the launch of boilerplate 12 at WSMR.

SUPPLEMENTAL AGREEMENTS TO CONTRACT NAS9-150

Supplemental Agreement 17, which provides for the incorporation of revisions to the priced spare parts list exhibit, has been executed by S&ID and NASA.

The proposed supplemental agreement that provides additional PERT contract coverage has been executed by S&ID and forwarded to NASA.

Supplemental Agreement 21, which provides a new inspection, acceptance, and delivery clause, has been executed by S&ID and NASA.

MANUFACTURING

Structural assembly of the launch escape tower for boilerplate 26 was completed. Stacking operations to determine the thrust vector alignment of boilerplate 23 were completed.

Bonding operations on the forward inner structure of the spacecraft 006 command module began during the report period.

A summary of GSE requirements and manufacturing unit completions is given in Table 1.

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Table 1. GSE Manufacturing Status

Vehicle	Total Units Required	Total Units Completed as of April 15	Units Completed Since March 15
Boilerplate 12	92	90	14
Boilerplate 13	105	102	15
Boilerplate 14	218	29	8
Boilerplate 15	49	29	20
Boilerplate 16	13	5	0
Boilerplate 22	51	0	0
Boilerplate 23	25	13	8
Boilerplate 26	9	7	7
Boilerplate 27	70	6	6
Test fixture F-2	51	19	6
Spacecraft 001	119	4	4
Spacecraft 009	332	0	0

[redacted]

DEVELOPMENT

AERODYNAMICS

Analyses are in progress to provide design data and to define the dynamic characteristics of the canard subsystem following abort. Preliminary loads and sequencing requirements were established. The WSMR flight test program was reviewed, and mission assignments were recommended by S&ID to NASA to provide flight demonstration of the canard subsystem (Table 2).

Table 2. Proposed Launch Abort Flight Test Program

Vehicle	Mission
Boilerplate 22	100,000 feet altitude for canard stability High $\bar{q}$ entry trajectory
Spacecraft 002	75,000 feet altitude plume impingement for tumbling command module-launch escape subsystem (LES) High $\bar{q}$ canard deployment from tumbling command module-LES
Spacecraft 010	36,000 feet altitude for booster maximum $\bar{q}$ test. Command module-LES stability Command module-LES structural integrity
Boilerplate 12	21,000 feet altitude for transonic abort Structural integrity of LES and its operational characteristics Demonstrate earth landing subsystem (ELS)

Determinations yet to be made in the flight dynamics area include:

1. Dynamics of the command module-LES with canard configuration for six degrees of freedom

2. Optimization of the altitude for changeover to manual orientation

3. Definition of the requirement to use the reaction control subsystem (RCS)

4. Definition of the manual orientation requirements

5. Definition of the drogue chute envelope

Supersonic tests were conducted with the command module-LES cold jet effects model to obtain command module pressure distribution at low thrust levels and high angles of attack. Transonic tests of the command module-LES hot jet effects model were conducted to evaluate the influence of the proximity of the service module on the aerodynamic characteristics of the command module-LES. Data from both hot and cold jet effects model tests are being analyzed.

MISSION DESIGN

A recent study indicates that a significant increase in the payload of the spacecraft is possible if a portion of the spacecraft-lunar excursion module adapter is jettisoned at the time of LES jettison. In the present configuration, the complete adapter is carried throughout the entire boost trajectory even though the loads which set its design occur only during the atmospheric phase of boost. During the remainder of the boost, the adapter is no longer subject to aerodynamic forces and undergoes only acceleration loads, which are less than half as large as those occurring during first-stage boost.

The possible payload weight improvement will depend upon added complexities associated with a jettisonable design and upon the percentage of the adapter jettisoned. Data showing the payload improvement possible for Saturn IB and Saturn V missions are given in Figure 1. Preliminary analyses indicate that it is feasible to design an adapter weighing 4000 pounds with 50 percent of its weight jettisonable. The resulting payload improvement over a 3400-pound non-jettisonable adapter would be 1121 pounds for the Saturn IB and 1227 pounds for the Saturn V.

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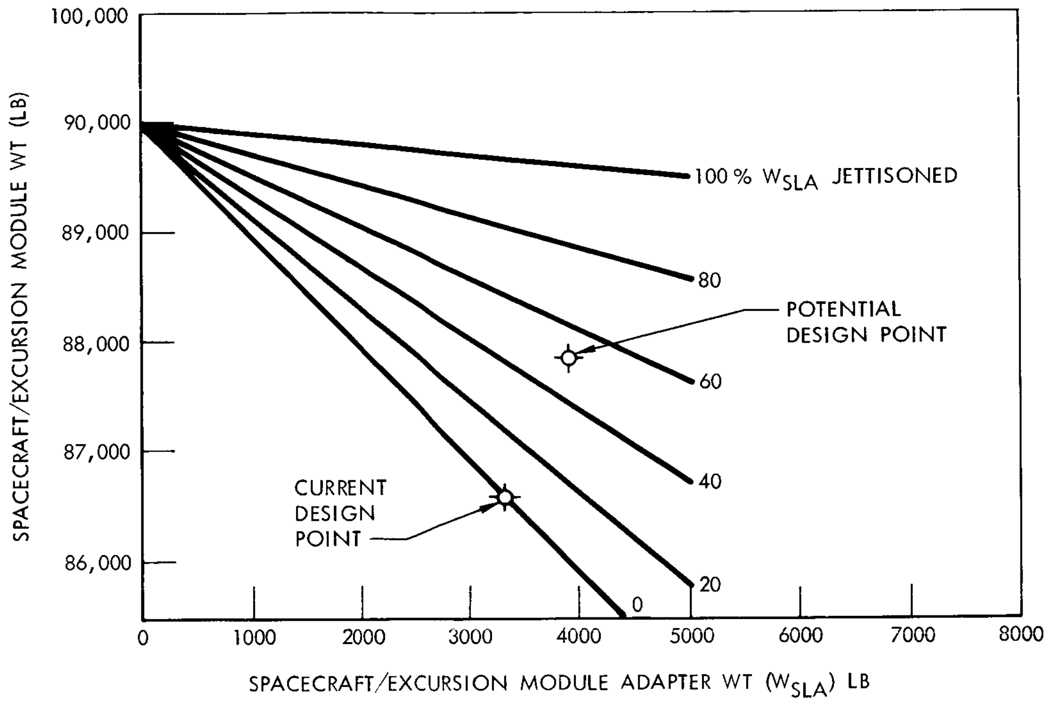
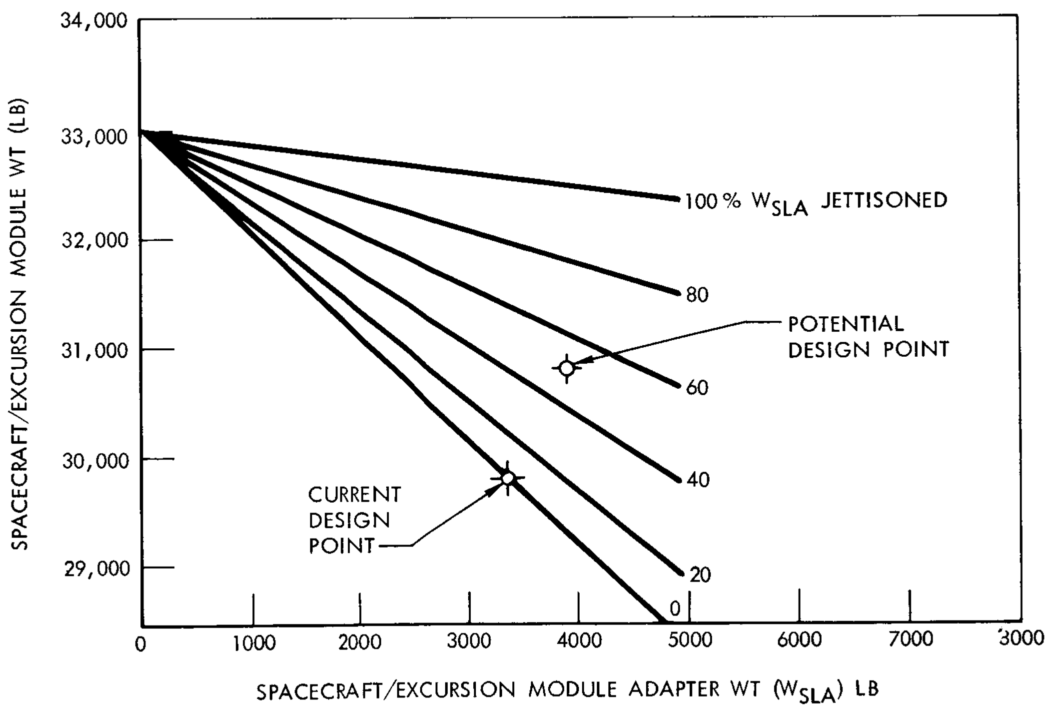


a. Effect for Saturn V Mission



b. Effect for Saturn IB Mission

Figure 1. Effect of Jettisoning Part of the Spacecraft/Lunar Excursion Module Adapter at LES Jettison

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The development and checkout of a precision trajectory digital computer program which converges on abort trajectories satisfying specified terminal constraints was completed. Input to the program includes the position vector, velocity vector, and time at the point of abort, plus the terminal constraints of entry altitude at a specified entry angle, inclination to the earth equator plane, and earth landing site latitude and longitude. The independent variables for satisfying the terminal constraints are the three components of velocity subsequent to an impulsive ΔV application at the abort point. North and south returns, long and short entry range solutions, and direct or retrograde abort trajectories can be obtained. This program, which is now operational, has functioned successfully for translunar abort points which are well within the moon's sphere of influence.

CREW SYSTEMS

Boost and abort simulations 1 and 2 were completed with a total of 660 training and 608 data runs. Two of the astronaut subjects were able to complete 50 training and 108 data runs under vented and pressurized conditions in a pressure garment received from NASA on March 19. Complete results of the simulation will be presented in a report scheduled for late April.

A preliminary test was conducted on March 24 to evaluate the capability of an astronaut wearing a pressurized spacesuit and a portable life support system (PLSS) to pass through the main crew access hatch (side hatch) for extra-vehicular activities. The purpose of this test was to verify a narrower hatch configuration proposed for block II spacecraft. A comparison of the dimensions of the present and proposed side hatches is given in Table 3.

Table 3. Comparison of Side Hatch Configurations

Dimension	Measurement (inches)		Proposed Decrease (inches)
	Present Configuration	Proposed Configuration	
Widest	39.528	31.856	7.672
Narrowest	28.410	22.895	5.515

[redacted]

The subject, wearing a pressurized, medium-regular size, International Latex Corporation state-of-the-art suit and a foam plastic, simulated PLSS, was able to enter and leave command module mock-up 2 despite difficulties resulting from the presence of gravity. The subject was relatively small (twenty-seventh percentile height, fifth percentile weight, and fourth percentile shoulder breadth). Inflated suit dimensions and clearances were sufficient to indicate that passage would be feasible through the proposed narrower main crew access hatch for a ninetieth percentile crewman wearing a pressurized Apollo spacesuit of the anticipated configuration.

A report entitled "Apollo Flight Crew Work Distribution and Control-Display Use Analysis for Selected Segments of a Lunar Landing Mission" was completed. This document presents an expanded computer program that includes the following data:

1. Apollo flight crew interdependency
2. Automatic (computer) check of the positional consistency of command module controls (toggle switches, rotary selector switches, etc.)
3. Frequency of control usage relative to crew tasks and mission times

Test requirements were prepared for the Apollo zero-gravity flight test program to be conducted at Wright-Patterson Air Force Base in late April. The tests will evaluate the potable water supply delivery system, crew couch restraint subsystems, the guidance and navigation (G&N) restraint subsystem, and extra-vehicular egress and ingress feasibility.

STRUCTURAL DYNAMICS

Dynamic flotation characteristics of a 1/10-scale model of the command module were evaluated in a series of tests with simulated random sea conditions in the testing tank at the Stevens Institute of Technology. In the second stable flotation attitude (overturned), water frequently reached the side hatch of the scale model during simulated sea states 3 and 4 (waves 6 to 10 feet high). The vehicle did not pitch, however, from the first stable (upright) position to the second stable attitude for the cg range tested, as had been expected from analytical studies. Investigations are under way to determine the reason for the difference between calculated and experimental results.

The acoustic chamber at NAA-Los Angeles is undergoing up-rating modifications. Upon completion of this work in May, an acoustic test will

[redacted]

be performed on a simulated 180-degree segment of the service module. This test will furnish information on the response of large curved honeycomb panel sections and will yield data on the capability and operating characteristics of this acoustic facility. The latter data are needed for acoustic tests of the full-scale spacecraft 007 command and service modules.

STRUCTURES

The command module window glass breakage test, conducted March 20, demonstrated the feasibility of using on-board tools to break the hatch windows for post-landing ventilation. The inner and outer window assemblies were tested separately. For each test the window assembly was rigidly supported. The engineer performing the test broke the glass with moderate arm effort using forearm motions only.

The design effort applied to panel splice plate separation for the spacecraft-lunar excursion module adapter is now concentrated on using mild detonating fuses (MDF) to produce plate shearing. The advantages of using MDF are ease of installation, minimum weight, minimum fragmentation, and high reliability. The first longitudinal joint test specimen with splices on both face sheets was fired. The inner splice joint had 2 inches of inert section on both strands of the 10-grain-per-foot MDF near the center of the panel. The outer splice joint had only one live strand of MDF; the second charge was replaced by a strand of solder. Both joints severed cleanly.

An S&ID analysis of the boilerplate 13 station 722 interface (between the instrumentation unit and the service module adapter) was presented to NASA-MSC and MSFC. S&ID recommended that the angle of attack of this boilerplate be held to a value that would limit the bending moment at the station 722 interface to a maximum of 5.77×10^6 inch pounds.

S&ID concurs with an Allison proposal that future service propulsion subsystem (SPS) fuel tanks be made with two cylindrical sections instead of four. Only minor development efforts are anticipated, primarily in the area of heat treat response and distortion.

Processing coldplates to the E revision of the manufacturing specifications and verifying the bond integrity with a 1000 psi pressure test has proven to be a satisfactory procedure. Nearly 60 coldplates were successfully processed in the past month as a result of this change. Attention and effort can now shift to post-bond operations, corrosion protection, and qualification testing.

A series of weld development and qualification studies of the new Inconel 718 pressure vessels were conducted by Airite Division, Electrada Corporation. Nine weld bands, each 6 inches long, and one full-scale sphere were welded and showed the electron beam welding technique to be very satisfactory. Non-destructive testing revealed no flaws. Beech Aircraft is currently conducting mechanical tests and microstudies of the welded pressure vessel.

FLIGHT CONTROL SUBSYSTEM

Stabilization and Control Subsystem (SCS)

Fabrication and checkout of the thrust vector control (TVC) test console and its instrumentation were completed. Prior to the availability of a TVC test set, a breadboard amplifier was fabricated and used successfully in preliminary amplifier performance verification, clutch electrical response checks, and open-loop actuator tests.

Preliminary arrangements were made for Honeywell to participate in docking simulation studies at the NAA-Columbus facility in May and June. A Honeywell simulator model of the flight director attitude indicator (FDAI) and rotational and translational controllers will be used in these studies.

Honeywell was authorized to perform a special study to determine detailed design changes needed to meet proposed revision of humidity requirements. The adoption of these new requirements will assure successful operation of the SCS in the possible presence of free water and corrosive contaminants during space flight missions.

Electronic Interfaces

Samples of the high reliability type of miniature incandescent lamps used on the command module main display console were subjected to vibration tests in excess of spacecraft vibration test requirements. The results were satisfactory.

A commercial cadmium-based lamp that meets Apollo requirements is now available for use, provided that satisfactory quality controls are maintained. In order to ensure minimum hours of use of the gold-based lamps in the lighted switch and annunciator assemblies, the cadmium-based lamps will be delivered with these assemblies and used for checkout activities. The gold-based lamps will be substituted for the cadmium-based lamps at a later time to achieve conformance with field site installation drawings.

Subsystem Analysis

A man-in-the-loop simulation study of service module abort was completed on evaluator 1. As all runs were begun at abort initiation, the emergency detection subsystem (EDS) was not included in this study. The EDS will be evaluated in subsequent simulations. Preliminary results of these evaluator runs are as follows:

1. The service module abort concept approved by NASA-MSC was found satisfactory for both manual and automatic subsystem operation.

2. The TVC is capable of handling all initial dynamic conditions in both SCS and G&N ΔV modes and, in all cases, would bring the vehicle under control within 10 seconds after the thrust-on signal.

3. The inertial measurement unit (IMU) reference may be lost due to gimbal lock for a small percentage of the abort conditions. If this loss occurs, the TVC operation in the SCS ΔV mode is satisfactory for arrest of tumbling and for obtaining the minimum required separation ΔV.

4. The separation sequencer functions that are currently being implemented are satisfactory.

The director and response tester secondary attitude control subsystem configuration and performance requirements were determined, and the procurement specification for the horizon sensor was written.

TELECOMMUNICATIONS

Communications

The El Toro Antenna Range has been established for the purpose of evaluating Apollo spacecraft antenna equipment. Construction and preliminary checkout of the facility are completed. Radiation pattern tests will begin for the VHF/2 kmc omni antenna equipment upon completion of range calibration (approximately May 15). Figure 2 shows the overall facility with a 1/3-scale model of the command and service module mounted on a two-axis rotatable head. Figure 3 shows the receiving and recording equipment, which is capable of making complete contour radiation plots at 2-degree conic intervals with 1-decibel variations.

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Figure 2. Overall View of El Toro Antenna Range

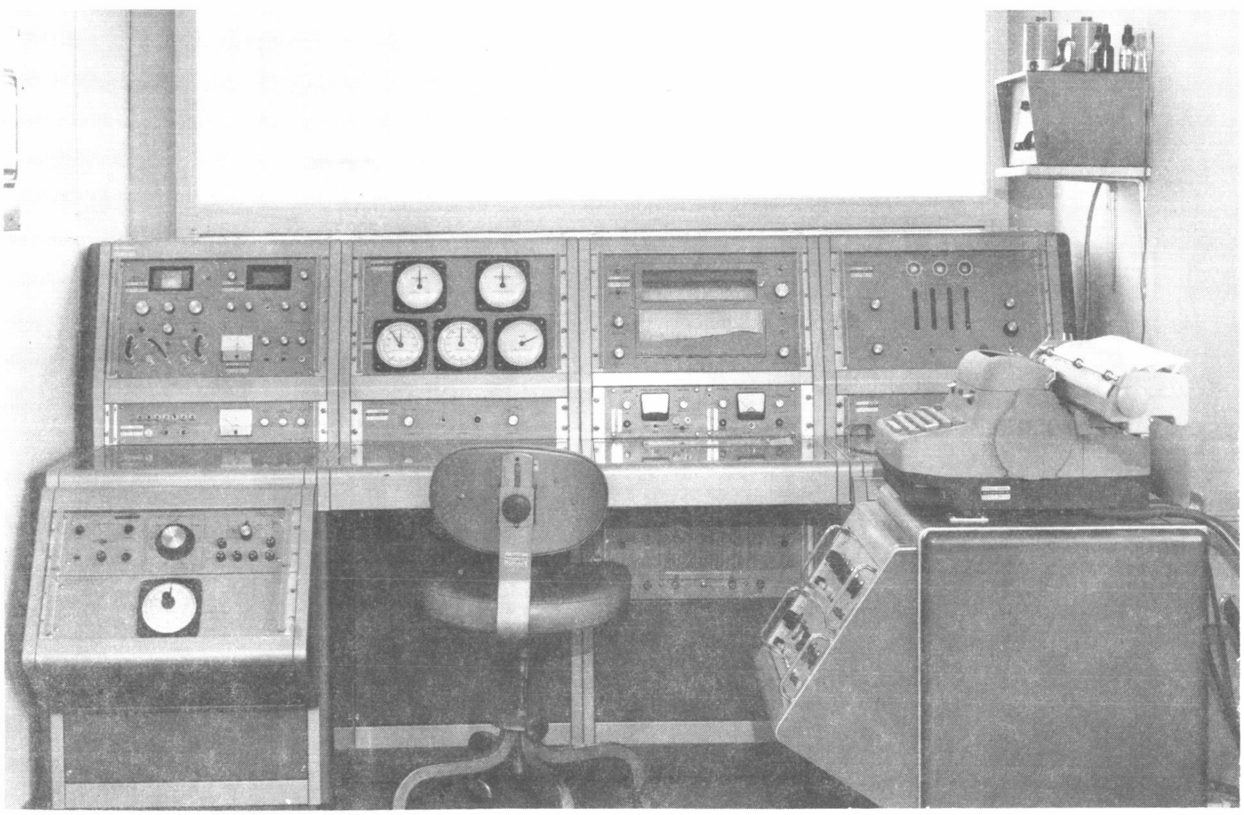

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Figure 3. Receiving and Recording Equipment at El Toro Antenna Range

A complete set of the communications equipment, except the signal conditioning equipment, was shipped to S&ID by Collins Radio. These units are E-models which have been used by Collins and their subcontractors in predesign proof tests to provide information for use in establishing D-model design. This set of equipment, and a second set now being employed in this test program, will be used at S&ID for engineering evaluation tests and in spacecraft ground operational support subsystem interface tests.

Instrumentation

Boilerplate 12 instrumentation subsystem tests are in progress in the stacked configuration at WSMR. Boilerplate 13 combined subsystem tests were successfully completed at Kennedy Spacecraft Center, and the vehicle was mated with the S-IV stage.

Modification of the Q-ball was successfully accomplished. The Q-ball will furnish information on angle of attack, sideslip velocity, and dynamic pressure. A qualified flight article was installed and checked out on boilerplate 12, and a spare unit was delivered.

The first instrumented anthropomorphic dummy is nearing completion. Instrumentation fit checks were completed, wiring is 80 percent complete, and calibration of instrumentation is 90 percent complete.

ENVIRONMENT CONTROL

A computer program for transient analysis was completed for the environmental control subsystem (ECS) radiator. Heat rejection and flow distribution were determined as functions of the environment in a nominal earth orbit mission. No serious flow distribution problems were encountered. This steady-state program can be used in cases above near-freezing conditions and is being expanded to encompass the near-freezing condition.

New heat loads for the water-glycol loop were compiled from updated information. The total load on the cabin heat exchanger for the proposed block II vehicles is greatly dependent on structural changes being considered. With the present structure, the cabin heat exchanger load varies from -2735 to +2810 Btu per hour. With the proposed structural changes, the load would vary from -215 Btu per hour to +1440 Btu per hour. The present capacity of the cabin heat exchanger is ±1500 Btu per hour.

Tests confirmed that approximately 10 feet of coiled 0.019-inch capillary tubing will provide adequate restriction for the oxygen supply lines. The oxygen surge tank is supplied through these restrictor orifices from the main oxygen supply. The orifices control the rate of surge tank repressurization to prevent surge tank demands from exceeding the capabilities of the main oxygen supply.

The first test of the interim ECS breadboard test program was completed on April 10 and included 4 hours of operation at simulated altitude.

Twelve ECS component end items were received from AiResearch for the first deliverable production subsystem, bringing to the total number of end items delivered by AiResearch to 31.

Analysis of potential radiation damage to the glycol coolant in the service module and the ECS thermistors in the command module was completed. The radiation level that will cause damage to these items is well above the levels expected for the solar proton design flare.

Although the combined effects of boost aerodynamic heating and LES motor plume impingement on the Teflon covers of the telemetry antennas of boilerplates 12 and 23 will produce the subliming temperature of 800 F, it was determined that only 0.012 inch of each cover will be lost due to ablation.

A study to determine the heating rates on the command module surface due to lunar excursion module RCS plume impingement during docking was completed. A maximum heating rate of 4.0 Btu per square foot per second occurs with the excursion module docked to the command module at the forward hatch. This value is recommended as a design parameter.

Design temperature histories of the LES canard during a 120,000-foot abort were calculated for a Saturn V boost and subsequent reentry. For an unprotected canard made of Inconel, the maximum temperatures on the leading edge and side are predicted to be 1100 F and 550 F, respectively.

ELECTRICAL POWER SUBSYSTEM (EPS)

Two fuel cell powerplants completed a successful 4-1/2-hour parallel load test at S&ID on March 31. This is the first time that two powerplants have been started in parallel.

[redacted]

Pratt & Whitney delivered the first three prototype B-powerplants on April 1. The subcontractor reports that one powerplant recently completed a 468-hour continuous run. Units at Pratt & Whitney successfully completed developmental tests simulating acceleration and vibration environments.

Preliminary results of performance tests of two solid state inverters at Westinghouse indicate that the efficiency requirements of the procurement specification have been met. Minor design changes in the control circuitry were required to overcome marginal performance.

The first entry battery was received from Eagle-Picher. Engineering evaluation tests will begin during the next report period.

A study was made of the cold soak time required to precool the insulation of the hydrogen vessels in order to reduce heat leakage to the hydrogen during subsequent prelaunch standby time. Cold soak time is measured from the completion of vessel filling until the start of top-off filling. Calculations were based on 29 pounds of initially saturated liquid hydrogen at 16.7 psia, with the end of standby time occurring when the pressure reached 250 psia. Values of heat leakage rates used were based on Beech Aircraft data from the EM-5 hydrogen vessel that had been modified so that the steady-state heat leakage rate was 8.5 Btu per hour. Results showed that 16 hours of cold soak provided 37.9 hours of standby, 6 hours of cold soak provided 34.7 hours of standby, and 3 hours of cold soak provided the required 30 hours of standby.

The results of a burst test conducted at Beech Aircraft in the developmental program for the titanium pressure vessel are shown in Figure 4. It should be noted that no fracture occurred along the electron beam weld. The first qualification burst test of a preproduction titanium pressure vessel was successfully completed on April 9. The recorded burst pressure was 1419 psi at -420 F. The mode of fracture was ductile, as indicated by full shear. The liquid hydrogen used as the test medium did not ignite. Three additional titanium preproduction vessels are undergoing qualification testing, and eight production titanium vessels are undergoing acceptance tests.

Marquardt Corporation selected Cameron Iron Works to supply the Inconel 718 forgings for the oxygen surge tank. The first forging is scheduled for delivery on April 27, and the first surge tank delivery from Marquardt is scheduled for August 3. The Inconel 718 pressure vessels will be welded during the next report period.

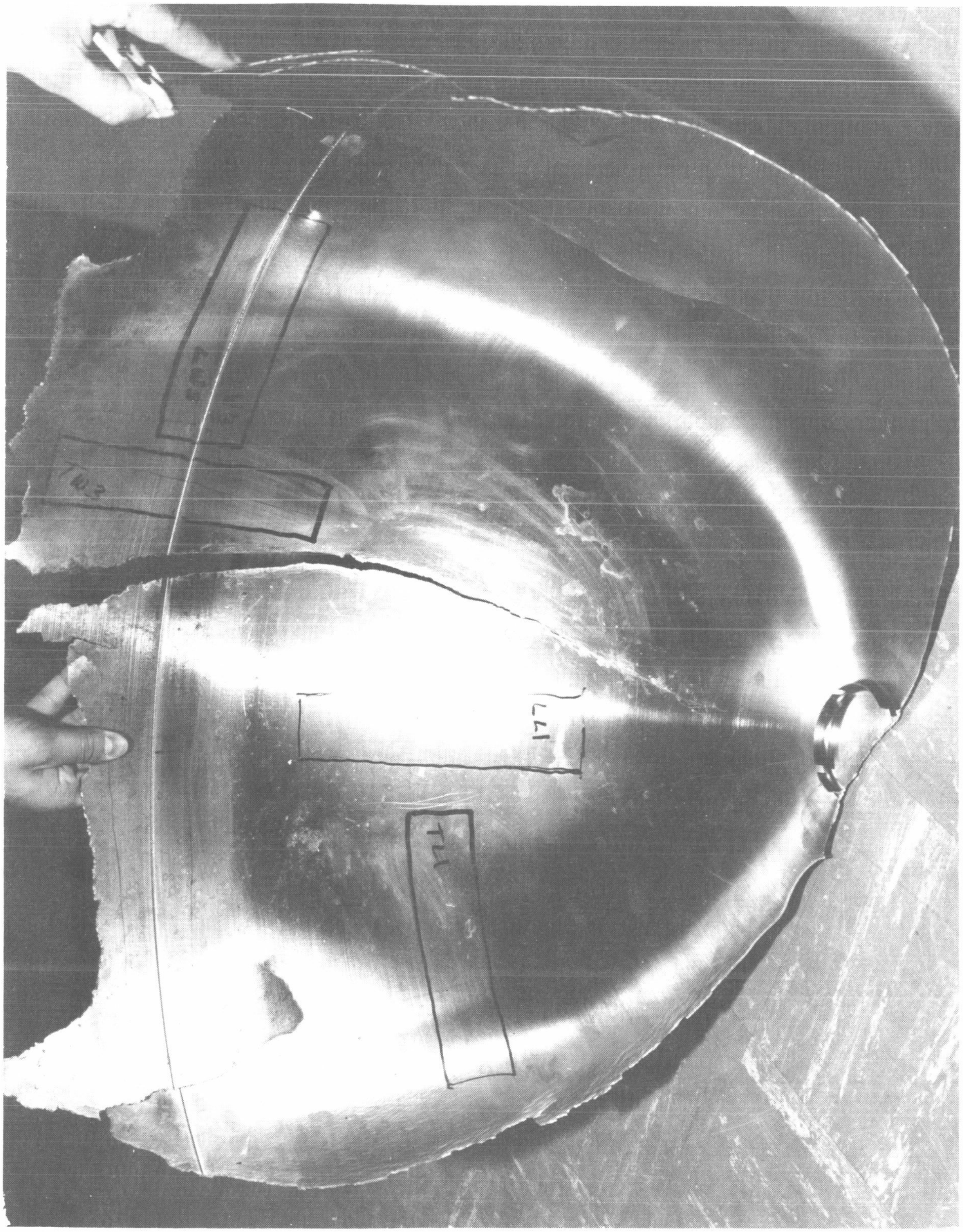

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Figure 4. Results of Cryogenic Burst Test of Titanium Pressure Vessel

The quartz lamp developed by General Electric for command module floodlighting will not meet the candlepower and life requirements. Resolution of the problem is being studied. The possibility of retaining the existing fixture envelope and using a 28 v incandescent lamp in place of the quartz lamp is being investigated.

An investigation shows that a manufacturing capability exists to produce subminiature connectors that would meet requirements for usage in the Apollo vehicle. Use of these connectors would result in substantial weight and space savings. A procurement specification is being prepared to obtain these connectors for block II vehicles.

A Boolean simulation switching analysis of each operating mode of the power distribution subsystem was completed. The results indicate that there is sufficient redundancy to ensure correct switching operation.

PROPULSION SUBSYSTEM

Service Propulsion Subsystem (SPS)

Forty-seven engine firings were accomplished in the engine development program at Aerojet-General and at AEDC. The first engine assembly incorporating a baffled injector was tested at AEDC on April 4. A maximum total operating time of 618 seconds was accumulated on one engine assembly at AEDC during the course of 23 firings in simulation of a mission duty cycle.

The injector development program is continuing, with 92 firings conducted at Sacramento during this report period. Investigation of the vibration problem at intermediate frequency (600 cps) is continuing.

Acceptance testing of the first deliverable SPS engine was completed, and delivery to S&ID is anticipated in late April.

Fabrication of injectors for the dynamic stability program is continuing, and the first of the six baffle units (Figure 5) was completed.

Table 4 lists all firings performed during this report period.

Reaction Control Subsystem (RCS)

A thrust chamber failure occurred on a service module RCS engine during pulse mode testing at Marquardt Corporation on March 31. Preliminary analysis indicates that the failure was caused by excessive

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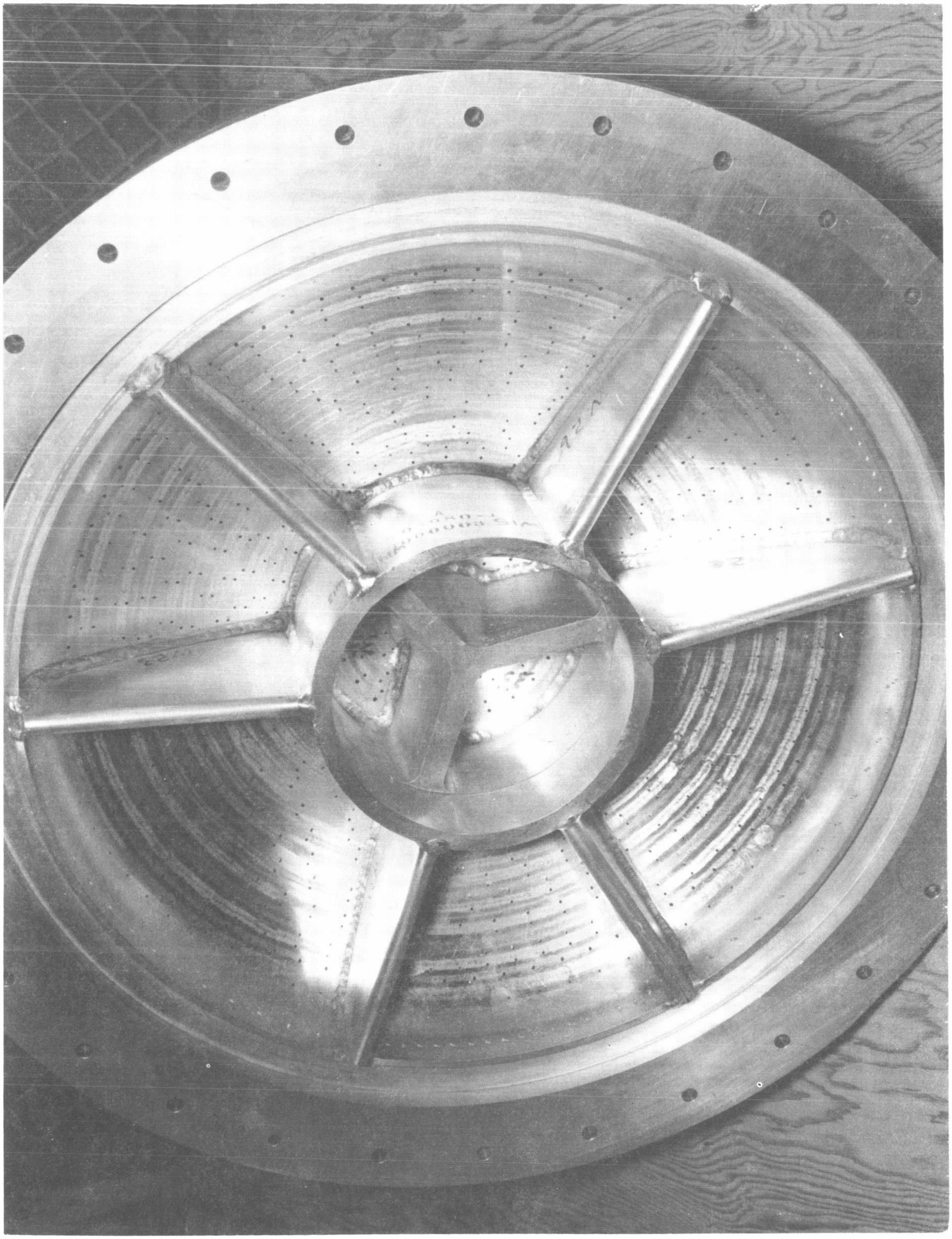

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Figure 5. Injector and Baffle Unit for Dynamic Stability Program

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Table 4. Injector Development Test Program for Apollo SPS Engine

Serial No.	Pattern Type	Type of Evaluation	No. of Firings (Ablative Chamber)	Time (seconds)	No. of Firings (Steel Chamber)	Time (seconds)	No. of Engine Firings	Time (seconds)	Remarks
AFF-32	POUL-31-37	C* & pattern performance			5	27			Satisfactory
		Checkout for mission	2	92					Satisfactory
		Mission duty cycle	22	528					Chamber burn-through in 3 places. 600 cps evident[1]
	POUL-31-43	600 cps investigation[1]	12	504					600 cps evident[1]
		Checkout for mission	2	91					Satisfactory
		Mission duty cycle	4	395					Test terminated because of excessive erosion. 600 cps evident[1]
	POUL-31-34	600 cps investigation[1]			6	30			Satisfactory
AFF-28	POUL-31-42	600 cps investigation[1]			3	21			600 cps evident[1]
		Checkout for mission	2	92					600 cps evident[1]
		Mission duty cycle	2	25					Test terminated because of excessive erosion

[redacted]

[redacted]

Table 4. Injector Development Test Program for Apollo SPS Engine (Cont)

Serial No.	Pattern Type	Type of Evaluation	No. of Firings (Ablative Chamber)	Time (seconds)	No. of Firings (Steel Chamber)	Time (seconds)	No. of Engine Firings	Time (seconds)	Remarks
AFF-29	POUL-31-44	600 cps investigation[1]			3	22			600 cps evident[1]
AFF-27	POUL-31-39	600 cps investigation[1]			9	26			6 CSM[2] shutdowns. Organ pipe dampeners in injector manifolds
AFF-56	POUL-31-10	600 cps investigation[1]			5	29			Satisfactory
AFF-72	POUL-31-10	C*			3	18			Satisfactory
		Injector/chamber compatibility	1	201					4 prominent gouges
BF-18	POUL-41-8	C*			5	29			Satisfactory
		Injector/chamber compatibility	2	401					Slight gouging
BF-19	POUL-41-8	Induced instability			4	25			156.9 grain pulses. Satisfactory recovery
0006	Engine assembly	Balance & acceptance test firings					5	39	Pilot valve difficulties
AEDC 0002 (6:1)	Engine assembly AFF-37 (POUL-31-10)	Simulated high altitude					4	104	Combustion instability on last firing. CSM[2] did not shut down engine.

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Table 4. Injector Development Test Program for Apollo SPS Engine (Cont)

Serial No.	Pattern Type	Type of Evaluation	No. of Firings (Ablative Chamber)	Time (seconds)	No. of Firings (Steel Chamber)	Time (seconds)	No. of Engine Firings	Time (seconds)	Remarks
AEDC 0003 (12:1)	Engine assembly AFF-23 (POUL-31-10)	Simulated high altitude Cell checkout					3	326	Satisfactory
		Simulated high altitude					21	615	All attempts to fire for 400 sec failed. Longest firing was 176 sec.
AEDC 0001 (6:1)	Engine assembly AFF-24 (POUL-31-10)	Simulated high altitude					7	558	3 attempts at 400-sec firing
AEDC 0001 (6:1)	Engine assembly BF-18 (POUL-41-8)	Simulated high altitude					7	379	Started 400-sec firing. After 265 sec stand fuel drain line failed and run terminated.

[1] Combustion instability at 600 cycles per second
[2] Combustion shutdown monitor

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internal pressure and resulted in the loss of approximately one-half of the combustion chamber. The throat and expansion nozzle were left intact. Marquardt is evaluating alternate chamber materials which may permit the use of larger structural design margins.

Environmental tests are now under way at Rocketdyne on a command module RCS engine that is similar to the prequalification configuration except for the propellant valves. Entry vibration tests at low temperature were successfully completed in two axes.

Design verification testing of the command module helium pressure regulator was completed by Stratos-Fairchild.

The phase II breadboard of the service module RCS was completed and is now ready for qualification testing. Completion of the phase II breadboard of the command module RCS is being expedited.

Launch Escape Subsystem Motors

Thiokol completed the tower jettison motor pyrogen ignition subsystem tests with the modified pellet basket and the type 2A cartridge functioning together successfully. After completion of the pyrogen tests, the last development motor was fired with this same ignition subsystem, completing the development testing of this motor.

The first qualification firing of the tower jettison motor is scheduled for April 16. The first two firings will remove the tower jettison motor constraints for all boilerplate vehicles not having boost protective covers.

Lockheed completed analysis for the launch escape motor development program and will begin qualification tests of both launch escape and pitch control motors. This analysis was reviewed and presented to NASA-MSC on April 1. Lockheed expects to cast the first qualification launch escape motor by late April.

Propulsion Subsystem Analysis

The study of propellant behavior under low gravity conditions is proceeding on schedule. The drop tower equipment package is in final assembly and checkout. Rigging of the drop tower is 80 percent complete, and the drag shield is in place. Trial motion pictures were made under simulated drop conditions, and checkout drops began on March 27. The zero-gravity program for the KC-135 aircraft flight tests at Wright-Patterson Air Force Base (scheduled for April 26 through May 9) was formulated, and test equipment is being designed.

[redacted]

During post-atmospheric abort, the nozzle of the SPS engine and the S-IVB adapter must be separated by an estimated minimum of 45 inches to permit safe ignition of the SPS engine on block II vehicles. The block I distance remains at 60 inches. The block II change results from the new rose-petal design for separation of the adapter panels.

A diurnal analysis of LES motor temperatures was completed for Kennedy Spacecraft Center launch pad climatic extremes. Maximum and minimum propellant grain temperatures over a 2-day period, and under the conditions of the analysis, were 91 F and 11 F, respectively. The probability of encountering these climatic extremes and the added temperature effects of boost heating are presently being evaluated.

DOCKING AND EARTH LANDING

Six main parachute drop tests were conducted at El Centro during the past month in an effort to slow disreef opening time and reduce blanketing of the main chutes in cluster. Results showed that 100 percent vertical tapes adversely affected cluster performance, while mid-gore reefing and removal of a portion of a ring in the crown of the canopy improved performance.

The boilerplate 12 sequencer subsystems are being modified to eliminate single-point failure potentials in the hot line abort circuit and the motor switch reset lockout relay circuit.

Mission sequencers for boilerplate 13 are being modified to remove single-point failure potentials associated with the present solid state circuit design.

Data runs were completed on the 29.5-inch crew transfer tunnel using the Gemini and the model 024 pressure suits. Unaided transfer was made by the test subjects when wearing either suit but not the portable life support subsystem (PLSS) pack. Subjects wearing the PLSS pack were unable to complete the transfer.

GROUND SUPPORT EQUIPMENT

A letter of intent was given to Control Data Corporation on March 13 for the fabrication of the digital test command subsystem (DTCS) for the acceptance and checkout equipment (ACE-SC). Delivery is scheduled as shown in Table 5. This schedule will support the activation of the ACE-SC ground station at Downey. The qualification unit will be fabricated and qualification tests completed prior to the delivery of set II.

Table 5. Delivery Schedule for DTCS for ACE-SC

Set	Description	Scheduled Delivery Date
I	Carry-on receiver and partial baseplate unit (engineering prototype fabricated to the signal configuration with certain waivers to the specification)	Jun 30
	Balance of carry-on baseplate unit	Jul 31
	Extra DTCS	Jul 31
	Service DTCS (full pre-qualification unit)	Sept 1
II	Qualified DTCS unit	Oct 1
III	Qualified DTCS unit	Nov 1

All design was released for the carry-on J-box for the ACE-SC response subsystem. Five signal conditioning units are in the final breadboard stages, and release of drawings was begun. NASA reviewed the data acquisition adapter concept and requested that the unit be fabricated in three groups of equipment racks. This will permit easier installation and independent checkout of the facilities measurements at Houston and at Downey. Design is proceeding on the basis of the latest NASA measurement list.

Block specifications were completed for four ACE-SC subprograms. Sixteen up-link and 12 down-link specifications were completed to define the general programming test requirements needed by General Electric for detailed programming of the ACE-SC computer. The general test requirements will be submitted to General Electric in the required format.

The original concept for the ten fluid distribution subsystem control units (FDSCU) models required packaging in standard equipment bays. To reduce the size of the hardware, a standard suitcase package was designed which can be used for control of any fluid distribution subsystem by applying the appropriate panel overlay to identify specific switch and meter nomenclature. The liquid hydrogen FDSCU and the potable water FDSCU were approved by NASA at the 30-percent concept review. Design was completed for six of the ten FDSCU models. Only the panel overlay remains to be designed for the other four models.

A typical bay of a special test unit (STU) model was completed for use in engineering evaluation of subsystem operation. Figure 6 shows an assembled bay with several standard modules installed. Blank panels are provided for installation of other standard and special modules as required for various subsystem tests.

The redesign of the pyrotechnic substitute unit was released during this report period. The redesign of this unit resulted in increased reliability due to the reduction from 67 to 6 parts per individual unit and the deletion of the associated bench maintenance equipment. This redesign necessitated design changes in the pyrotechnic initiator. The latter unit will use 28 v facility power, thus eliminating the need for separate power supplies. The redesigned pyrotechnic initiator unit is scheduled for delivery by early July and will support test schedules.

The filtration level of the propulsion subsystem fluid checkout unit was changed from a range of 10 to 25 microns to a range of 5 to 15 microns. This change is effective on the basic model as well as the -101 and the -201 configurations, and is necessary to meet propulsion subsystem cleanliness requirements. Procurement of the necessary filters was begun.

The initial compiler to be used in the programming of spacecraft instrumentation test equipment (SITE) (Comsite I) was completed, and sample programs were tape-punched to verify its validity. A second phase of compiler development was initiated in which the inputs are typed directly from the process specification.

A list of all GSE models identifying the qualification tests to be performed on each item was completed. The list was presented to NASA-MSC, and the problems of implementing the qualification test program were discussed. Suggested changes are being incorporated.

A mission sequencer test will be performed on boilerplate 12 upon receipt of a sequencer from WSMR. Incompatibility between the sequencer and the pyrotechnic initiator substitute unit prevented shipment of the sequencer as scheduled. Resolution of the problem is being expedited.

Boilerplate 13 GSE integrated checkout was conducted on April 3. All units performed satisfactorily.

In compliance with a recent NASA request, certain models of GSE will be tested prior to delivery to assure safe ignition qualities during use in a hazardous area. Since boilerplate 22 uses hypergolic fuels in a functional area, approximately 18 items of GSE will be given comprehensive tests.

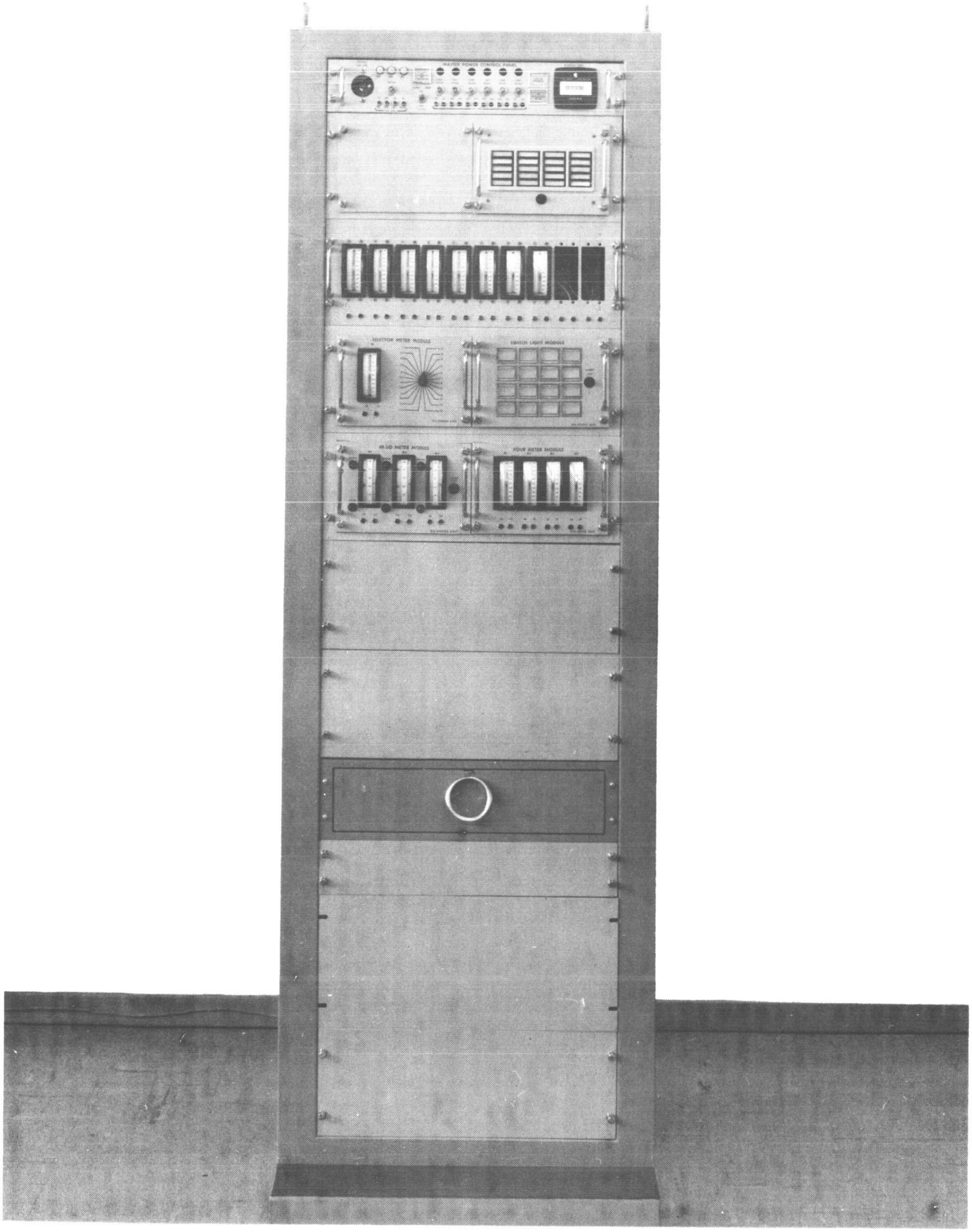

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Figure 6. Special Test Unit (STU) Bay

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SIMULATION AND TRAINERS

A docking study will be conducted by S&ID at the NAA-Columbus facility during the period from May 11 to July 10. The purpose of this study is to investigate the Apollo alignment capability during the docking phase with the astronaut test subjects using various optical devices. Control subsystems behavior, propellant consumption, and variations of target illumination will also be studied. The docking simulator consists of a visual display subsystem of the lunar excursion module, an Apollo command module mock-up, interface electronics, and the computer mechanization.

An interface electronics equipment cabinet was developed and fabricated to increase the fidelity of the docking simulation. This console contains the following equipment:

1. Jet select logic
2. Transport log logic
3. Event timer
4. FDAI and Lear altitude indicator drive
5. Translational and rotational controller logic and drive
6. Power supplies

The addition of this equipment more accurately describes the flight control subsystem characteristics and also allows the incorporation of partial prototype SCS hardware. The equipment bay was completed and shipped to Columbus for incorporation into the docking simulator.

A real-time hybrid simulation of the entry flight phase (Figure 7) is scheduled to be operational by mid-May. The engineering simulation is designed to provide an evaluation of the Apollo entry flight subsystems, an analysis of failure effects, an evaluation of G&N steering concepts, and an analysis of crew tasks and procedures. Checkout of the software portion of the simulation, which uses three analog sections, an IBM 7040 digital computer, and a solid state logic console in combined real-time operation, is approximately 95 percent complete. The capability to provide software for real-time hybrid simulations was substantially increased by the mechanization and checkout effort expended on this simulation and will enchance future hybrid simulation endeavors.

PROJECT INTEGRATION

Checkout process specifications were reviewed to optimize the number and types required and to improve the generation, distribution, and control of changes. Two primary matrices will be used, one for

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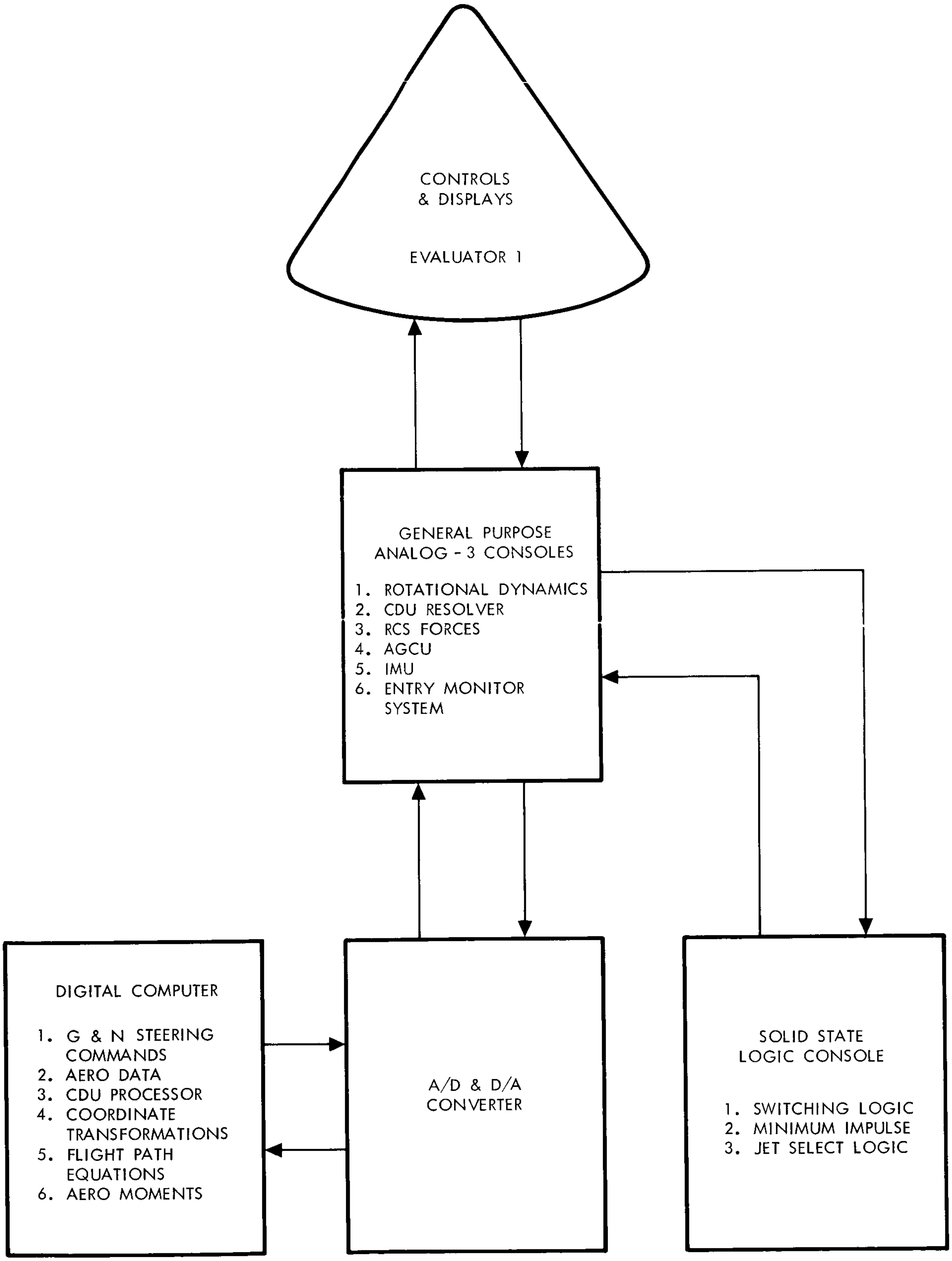

[redacted] Figure 7. Evaluator 1 Entry No. 2 Hybrid Simulation

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those processes with common-usage specifications and one for those peculiar to specific vehicles. Each vehicle matrix applies to the special requirements of that vehicle.

Within each of the primary specification types are four classes of specifications. These four classes take into account the variations of GSE and special requirements for various locations in the program. Class I specifications are those which are required for use in manufacturing. Class II specifications consider the requirements of Apollo test and operations and are related to Downey operations. Class III specifications are test- and operations-oriented and take into account the various unique field tasks. Class IV specifications are generated to satisfy the needs for ACE-SC programs and required operator instructions.

VEHICLE TESTING

The boilerplate 12 command module and LES were stacked on the Little Joe II booster on March 30. The flight-rated Q-ball was received and installed at WSMR. The electromagnetic interference process specification was released and coordinated with WSMR.

The eleventh in a series of drop tests was conducted on April 8 using boilerplate 19 as a test vehicle. The purpose of the test was to satisfy the final constraints for pyrotechnic cartridges and redundant reefing of the main parachutes prior to the flight of boilerplate 12. The vehicle was dropped from an altitude of 30,000 feet with the aft heat shield forward to simulate normal entry conditions. All subsystems functioned satisfactorily except the backup drogue, which deployed simultaneously with brake chute disconnect owing to a faulty radio command. The backup drogue is used as a safety factor on boilerplate 19 only. Even though this drogue malfunctioned, the test objectives were accomplished, and the boilerplate 12 constraints were removed.

Weight and balance determinations for the boilerplate 23 service module were completed during the week of March 27. On April 13, the forward cover, tower, and LES motor were removed after thrust vector alignment and reinstalled without the necessity of realignment in order to satisfy a requirement of the boilerplate 23 design engineering inspection (DEI). This procedure was successfully demonstrated by three removal-and-installation cycles. A process specification was written to incorporate the procedures established in the test. Incorporation of 37 outstanding engineering orders and submission of the final DEI report on boilerplate 23 are scheduled for late April.

Boilerplate 14 cable fabrication is under way. The plumbing mock-up is complete in the service module and approximately 60 percent complete in the command module. Induction brazing of the tubing assemblies was begun.

A checkout plan for spacecraft 001 was prepared on the premise of using GSE instead of the subsystem measuring device (SMD). Design and fabrication of the SMD will continue in order to provide a backup for critical GSE items. Checkout of the vehicle will be restricted to the service propulsion subsystem. The mock-up of the fuel cell powerplant plumbing is complete with the exception of one tube. The cryogenic plumbing mock-up is approximately 40 percent complete.

Plumbing and cable routing were started on the command module mock-up of spacecraft 006. This mock-up will provide exact plumbing line lengths and cable routings to form the basis for all future block I spacecraft fabrication.

Integrated tests of boilerplate 13 were completed on March 24 at Cape Kennedy, and outstanding engineering changes are being incorporated. Major changes are fluctuating pressure transducer mounts, ballast removal, adapter paint, targets for the service module, and mission sequencer redesign. All of these changes are complete except the mission sequencer redesign, which requires extensive engineering changes and manufacturing rework to eliminate possible single-point failure and prevent malfunction of the bias battery.

S&ID is currently reworking the sequencers. The first mission sequencer was completed and shipped to Cape Kennedy for installation in boilerplate 13. The second sequencer is scheduled for completion in late April and will be used as a spare for boilerplate 13. The two minimum airworthiness test (MAT) sequencers will be completed early in May, permitting resumption of these tests.

RELIABILITY

A major design review of the command module heat shield substructure was held. The feasibility of using titanium in place of stainless steel for the substructure is being evaluated as part of a weight reduction study for block II spacecraft. Added reliability and a weight reduction of several hundred pounds may be possible by taking advantage of the higher strength-to-weight ratio of titanium. Three factors will be considered in this evaluation: the embrittlement of stainless steel at extremely cold temperatures, the higher cost of titanium, and the verification of diffusion bonding of titanium honeycomb.

A new preliminary SPS duty cycle was defined that reduces engine operating time from 750 to 560 seconds. As a result, weight savings are realized in the propellant tank, engine chamber, and propellant. The

[redacted]

associated decrease in operating time and the increase in failure rate resulting from reduced design margins will offset each other. Thus, weight savings will be realized with a negligible degradation in overall engine reliability.

To date, 24 tower jettison motors have been fired with no unexplained failures. The modified pyrogen design for the tower jettison motor, incorporating the strengthened screen and the original 2A cartridge configuration, proved satisfactory. Preliminary indications are that the structural integrity of the propellant basket is improved. The last tower jettison motor development firing will be the first with a single ignition cartridge. The purpose of this firing is to demonstrate single-cartridge capability. Six firings of this configuration are scheduled. The results of tests to date have satisfied the minimum airworthiness reliability requirements for this motor for boilerplates 12 and 13.

TECHNICAL OPERATIONS

The following significant changes were authorized by NASA during this reporting period:

1. Glass samples are to be affixed to the exterior of the command modules of boilerplates 12, 22, and 23, for tests to be conducted to determine the amount and composition of deposits from the LES and tower jettison motors on crew windows and C-band antenna windows.

2. Monitoring of grain temperature is to be performed on LES motors during preflight build-up of the LES at Kennedy Spacecraft Center and WSMR. This will be accomplished by installing thermocouples on these motors.

3. Components and systems not required for an unmanned flight will be deleted. Provisions for automation will be added to perform the functions of an astronaut and the control of the spacecraft during flight.

4. Studies are to be performed to determine the feasibility of using the lunar excursion module propulsion system as a backup to the service module SPS in the event of a malfunction in the SPS prior to a certain point in the mission.

5. Launch vehicle guidance failure lights are to be added on the main display console of the command module for the emergency detection subsystem. This change provides a visual display of launch vehicle failure for the astronaut.

[redacted]

6. The crew restraint subsystem is to be redesigned to improve the couch mechanization, reduce gadgetry, and delete the requirement for translating and rotating the couches for various mission phases.

7. Certain components of the ECS will be redesigned to reduce the number of threaded fittings by incorporating modular casting and brazed manifold configurations. This change will increase reliability.

Command module mock-up 22 was approved by NASA on March 16. Detailed component fabrication is continuing for the updating of command module mock-ups 2 and 5 and service module mock-up 18. These mock-ups are being revised to reflect the latest changes to spacecraft 011 in preparation for the design engineering inspection (DEI) to be held April 28 and 29.

OPERATIONS

DOWNEY

The modifications of the mission sequencers for boilerplate 12 "ground test only," for qualification, and for the mission abort flight were completed. The three sequencers are in test. Two 41.1-second timer assemblies to be used with boilerplate 12 were fabricated and shipped to WSMR. S&ID will build four timers and will modify six mission sequencers.

The components of boilerplate 15 will be moved to the S&ID tower facility, stacking will be completed, and detailed systems testing will be started during the next report period. Detailed planning of the test effort for boilerplates 16, 23, and 26 and for spacecraft 001, 006, 008, and 009 will continue.

Boilerplate 14 will be delivered to the test preparation area during the next report period. Modification and updating will be accomplished, and installation of vehicle systems will be started.

WHITE SANDS MISSILE RANGE

Mission Abort

The boilerplate 12 earth landing subsystem (ELS) buildup and installation in the command module were accomplished at the WSMR vertical assembly building. Weight and balance and center of gravity were determined, and the launch escape motor thrust vector alignment was completed.

The boilerplate service module was modified by the installation of a transducer for in-flight monitoring of Little Joe II chamber pressure and thrust termination. The service module was then moved to the mission abort launch pad and mated to the Little Joe II booster vehicle.

Following service module mating, the command module was moved to the launch pad and mated to the service module/Little Joe II vehicle. The launch escape subsystem (LES) was then mated to the stack (Figure 8). Checkout of the interface with the booster vehicle was completed, and the electrical subsystems checkout and the ELS and LES sequencer functional verifications were accomplished. The telemetry and C-band transponder checks were completed, and the power-on checkout was started.

The vehicle is presently undergoing modifications for addition of backup abort initiation and for elimination of single-point failure. During the next report period, the modifications will be checked out and the functional verifications of the ELS and LES sequencers and the transducer systems will be rerun. The inspection and open-item review of the vehicle will be performed, and integrated systems test 1 and the simulated countdown will be completed. Upon completion of the flight readiness review, the prelaunch countdown will be initiated.

Propulsion Systems Development Facility (PSDF)

The fuel and oxidizer transfer units for test fixture F-2 were received from the S&ID-Tulsa facility, and receiving inspection was completed. The transducer and cable harness fabrication, installation, and verification were completed, as was the helium low-point drain valve installation.

The checkout of the special cables for the vapor disposal units was accomplished. The bulk cable portion of the set was installed and verified.

The data supporting the acceptance testing of the first engine for test fixture F-2 were declared to be satisfactory. The engine was cleaned, and preparations are under way for shipment to WSMR on April 20.

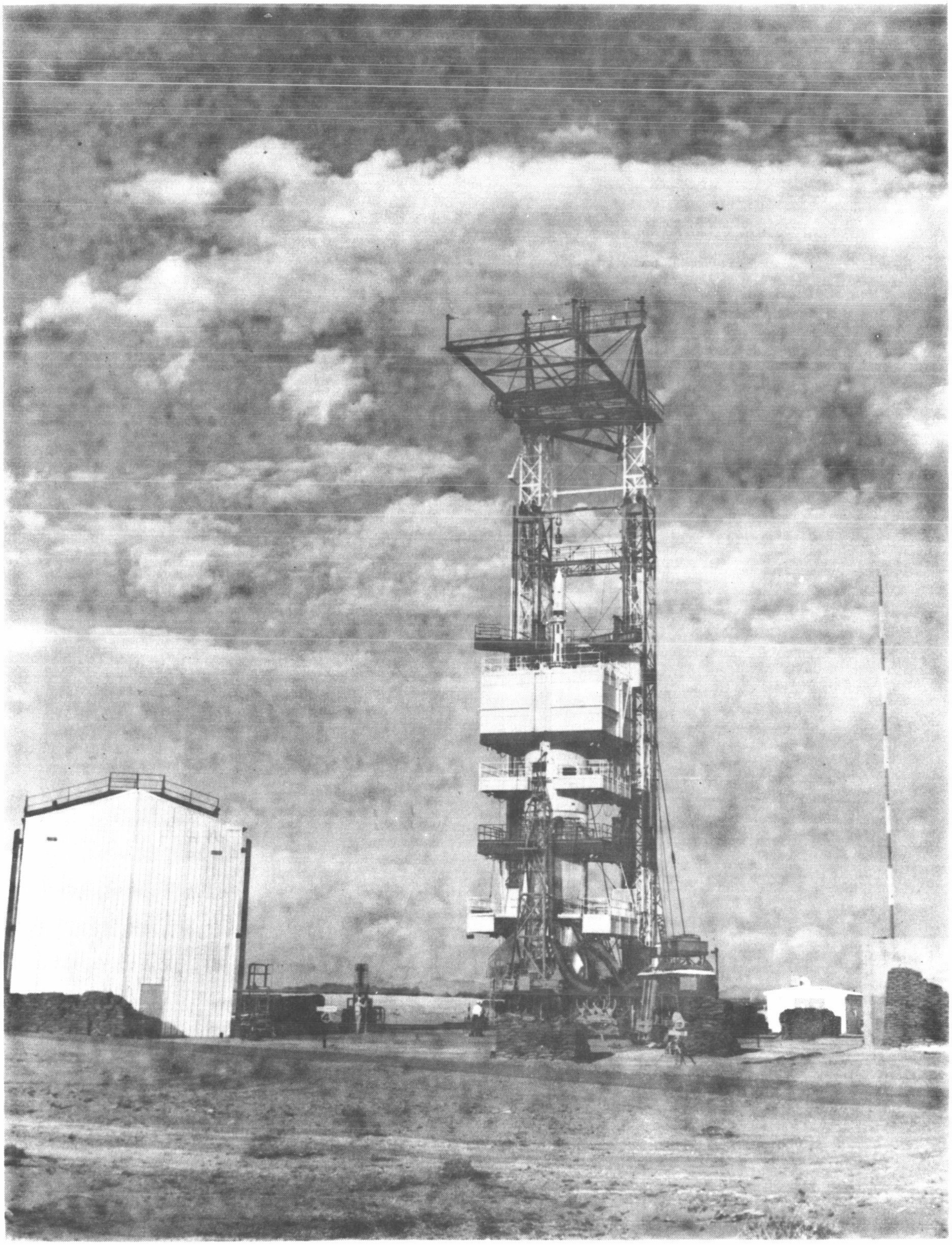
The kit for modification of the PSDF fluid distribution system was received, and installation of the system was started. The revised completion date is May 4, and the first firing for test fixture F-2 is now set for June 30.

The calibration of the PSDF data acquisition system (DAS) instrumentation equipment was accomplished. The reduction of data obtained from the DAS 100-hour acceptance test was completed.

During the next report period, the functional and leak checks of the propellant portions of test fixture F-2 will be completed. The installation, system cleaning, and checkout of the fluid distribution system will be accomplished. The engine for the test fixture will be received and will undergo receiving inspection. The transducer installation and checkout will then be accomplished, and the engine will undergo leak and functional checkout.

FLORIDA FACILITY

The integrated systems checkout of boilerplate 13 was completed in hangar AF on March 25, thus fulfilling all hangar test requirements for this



WSMR-64-BP12-75

Figure 8. Boilerplate 12 Mated to Little Joe II Booster at WSMR

boilerplate. The vehicle and associated GSE were moved to launch complex 37B on April 2.

The boilerplate was physically mated to the Saturn I launch vehicle (SA-6) on April 2 (Figure 9). The mating and alignment of the launch escape system with the command module were also completed on April 2.

The first integrated systems test at the pad was completed ahead of schedule on April 13. This test demonstrated and verified the compatibility of the boilerplate electronic, mechanical, and electrical systems during a sequence of operations simulating the spacecraft launch conditions. The launch vehicle substitute unit provided the booster interface for this test.

The ballast removal directed by NASA for boilerplate 13 was performed on March 23. A total of 1600 pounds of ballast was removed from the service module and adapter.

Boilerplate 13 checkout operations will continue at complex 37B during the next report period. The electrical mating of the boilerplate to the booster on April 20 will be followed by a series of boilerplate/launch vehicle joint checkouts.

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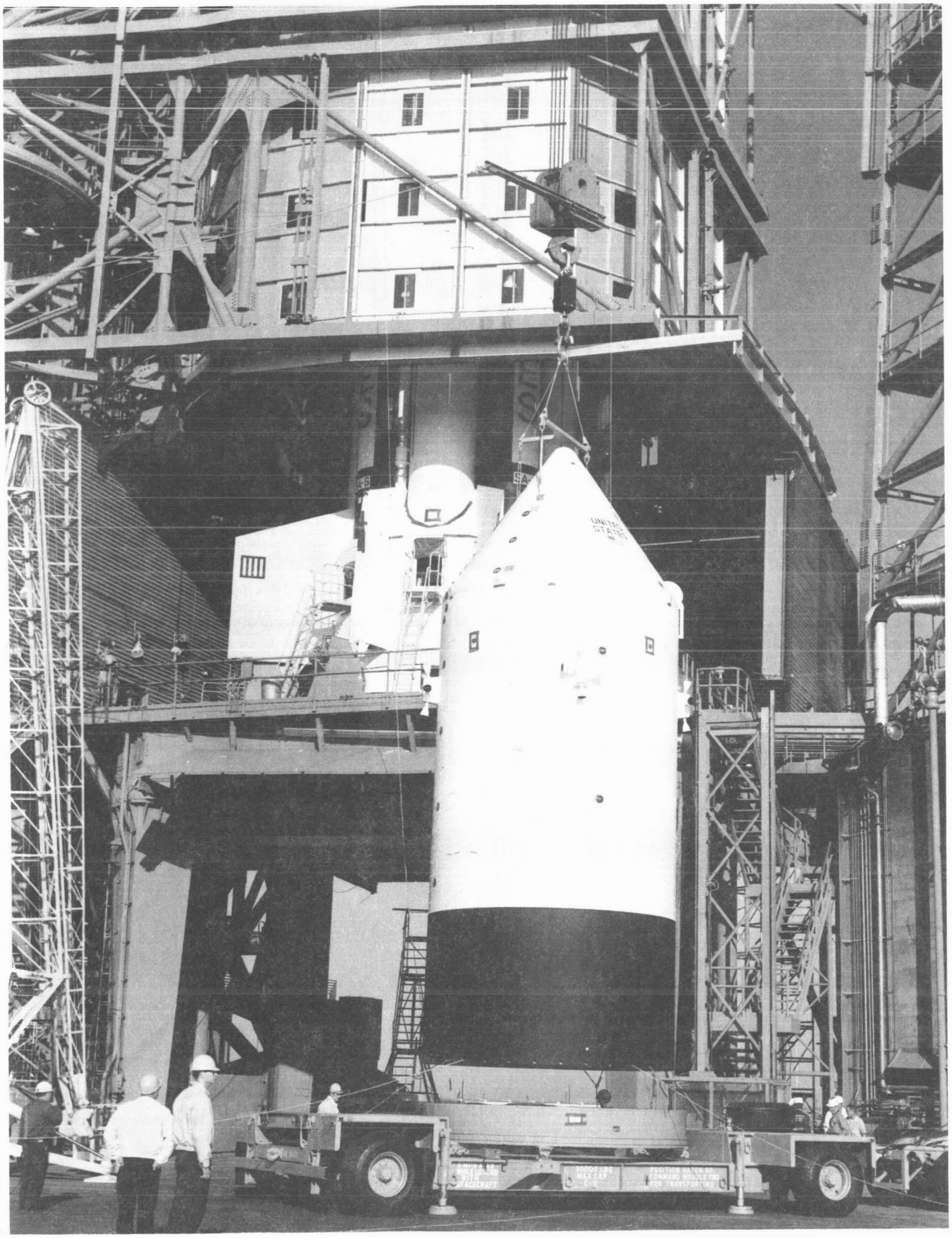

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Figure 9. Preparations for Mating Boilerplate 13 to Saturn I Launch Vehicle SA-6 at Florida Facility

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FACILITIES

DOWNEY

Space Systems Development Facility

S&ID began to occupy all areas of the space systems development facility on April 11, except for the tower section, where electrical work and installation of the pit steel are continuing. Completion is scheduled for April 17. The space bearing and space simulation laboratory (clean room) was completed on April 9.

MIT Laboratory

Move-in and placement of all MIT equipment was completed on April 13. Construction work, except for installation of heat detectors, was completed on April 15.

INDUSTRIAL ENGINEERING

Tube Processing Building

Construction is complete and equipment is being installed in the Apollo tube fabrication and cleaning operations center at Downey (Figures 10, 11, and 12). The facility contains fabrication equipment, precleaning tank systems, and plating equipment for aluminum and stainless steel tubing. Clean rooms are provided to house final cleaning operations, inspection and packaging functions, and quality control laboratories.

The building, located adjacent to the bonding facility, is currently 12,000 square feet in area and will be extended an additional 2400 square feet to accommodate salt bath brazing operations. Design work for the building extension and salt bath brazing equipment are now in progress and are scheduled for completion on May 1. Operations are scheduled to begin in July of this year.

General Electric Area Plan

A Downey area plan and assignment for General Electric was completed and approved. The plan provides trailers for office personnel, floor space in Building 3 for warehousing, and maintenance and overhaul space in Building 290 and its planned extension.

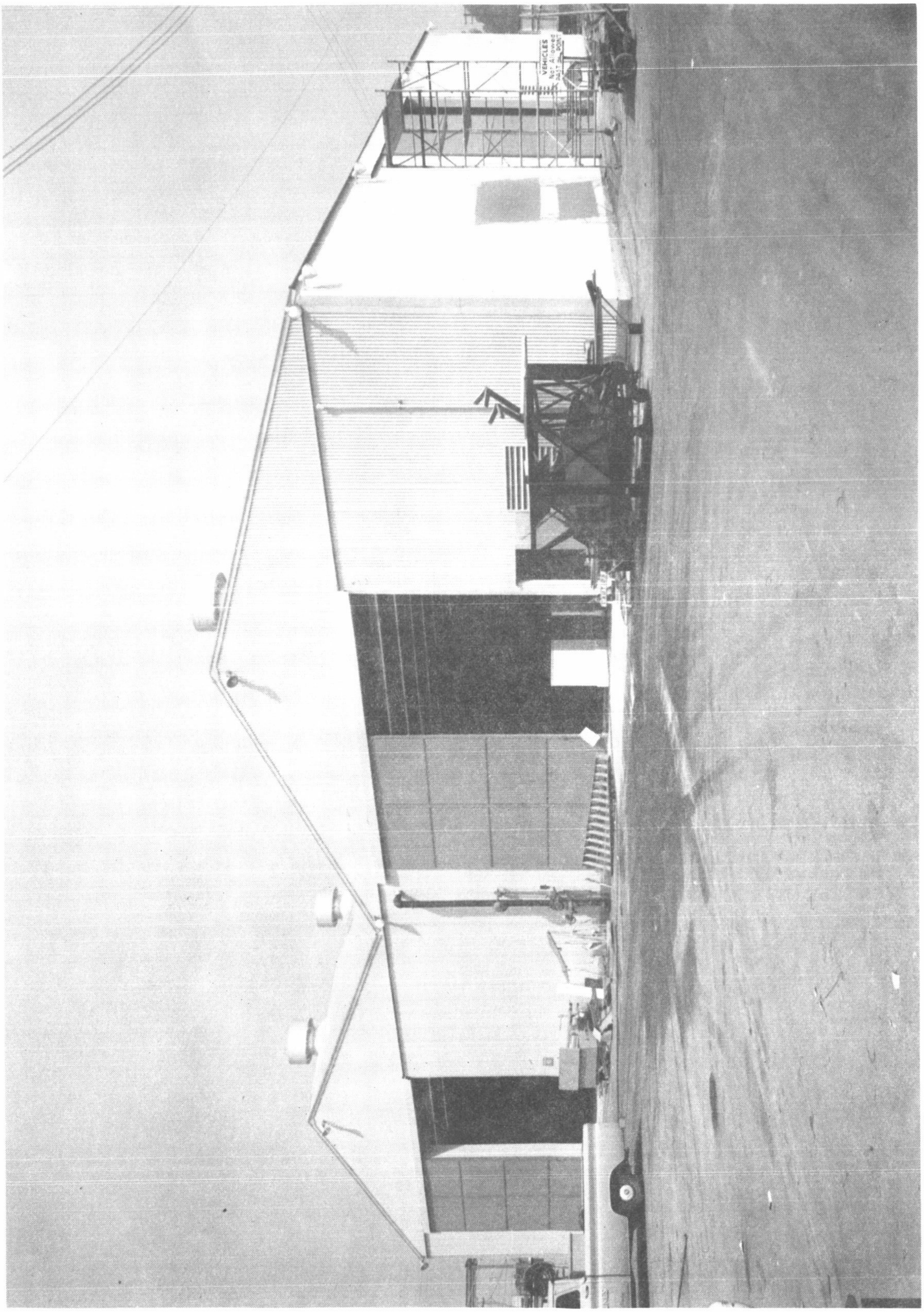

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Figure 10. Apollo Tube Fabrication and Cleaning Operations Building

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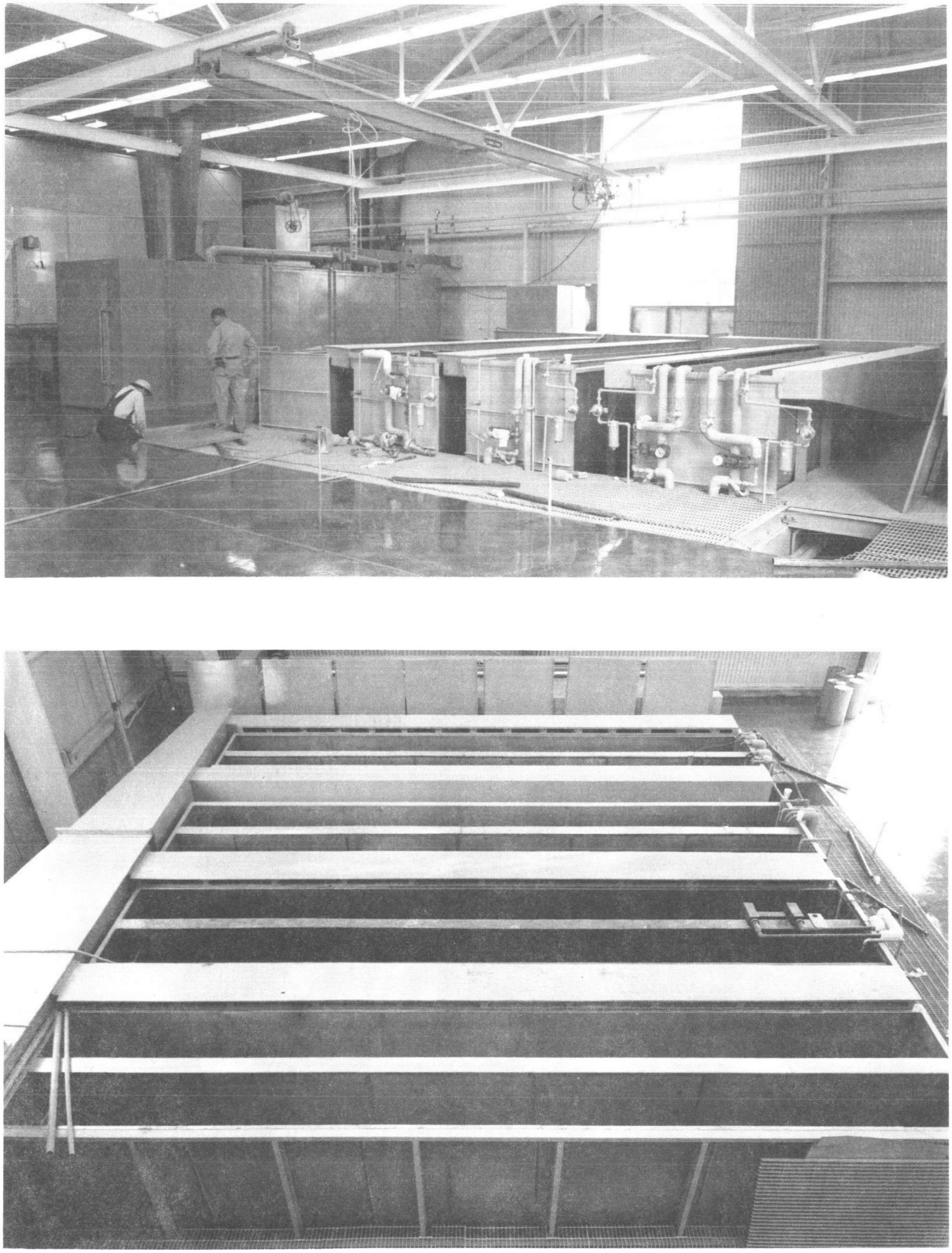

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Figure 12. Aluminum and Stainless Steel Tube Plating Facility

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APPENDIX

S&ID SCHEDULE OF APOLLO MEETINGS AND TRIPS

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S&ID Schedule of Apollo Meetings and Trips
March 16 to April 15, 1964

Subject	Location	Date	S&ID Representatives	Organization
Humidity test coordination and observation	Cedar Rapids, Iowa	March 15	White	S&ID, Collins
Preparation of qualification test (witness)	Phoenix, Arizona	March 15 through 17	Gibb, Large	S&ID, Cannon
Boilerplate 12 EMC test discussions	Las Cruces, New Mexico	March 15 through 18	Pumphrey	S&ID, NASA
Mechanical integration panel meeting	Houston, Texas	March 15 through 21	Tooley, Johnson, Snook, Dupaquier, Miller	S&ID, NASA
FSJ-1 testing	Hampton, Virginia	March 15 through April 3	Daileda	S&ID, NASA
Boilerplate 13 GSE support	Cocoa Beach, Florida	Beginning March 15	Embody	S&ID, NASA
Post-landing hazards and safing procedures	Houston, Texas	March 16, 17	Petrey, Corrigan	S&ID, NASA
Methods of transmittal of Apollo CCMR data	Houston, Texas	March 16 through 18	Harper	S&ID, NASA
Monthly coordination meeting	Sacramento, California	March 16 through 18	Melink, Goodzey, Barker, Briggs	S&ID, Aerojet
Management plan configuration control	Cedar Rapids, Iowa	March 16 through 19	Campbell, Newman	S&ID, Collins
Stoddart-Tamar connectors	Cedar Rapids, Iowa	March 16 through 19	Berkemeyer, Molden, Marushak	S&ID, Collins
Project coordination	Minneapolis, Minnesota	March 16 through 19	Watson, Miller	S&ID, Honeywell
Site activation coordination	Houston, Texas	March 16 through 19	Mundy, Moore	S&ID, NASA
Acceptance test procedures review	Cedar Rapids, Iowa	March 16 through 20	Griffiths	S&ID, Collins
Project engineering coordination	Sacramento, California	March 16 through 20	Mower	S&ID, Aerojet
Configuration control	Cedar Rapids, Iowa	March 16 through 21	Gill	S&ID, Collins
Project engineering coordination	Sacramento, California	March 17	Borde	S&ID, Aerojet
Mission simulator visual display	Houston, Texas	March 17, 18	Barnett, LaFrance Brown	S&ID, NASA
Technical presentation	Houston, Texas	March 17, 18	Benington	S&ID, NASA
GSE review	Sacramento, California	March 17, 18	Harlan, Nakamura	S&ID, Aerojet

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S&ID Schedule of Apollo Meetings and Trips
March 16 to April 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Space suit assembly mechanical interfaces	Houston, Texas	March 17 through 19	Brockman, Roebuck, Opdyke, DeWitt, Zelon	S&ID, NASA
Field analysis negotiation and program status review	Middletown, Ohio	March 17 through 19	Stover	S&ID, Aeronca
Technical coordination	Cedar Rapids, Iowa	March 17 through 20	Schepak, Kowaleski	S&ID, Collins
G&N interface thermal requirements	Cambridge, Massachusetts	March 17 through 20	Richie	S&ID, MIT
Full protection suit evaluation	Cocoa Beach, Florida	March 17 through 20	Landstrom	S&ID, NASA
Project engineering representation for boilerplate 13 operations	Cape Kennedy, Florida	March 17 through April 8	Everett	S&ID, NASA
Field operations project engineering support	Cocoa Beach, Florida	March 17 through April 14	Hartzel	S&ID, NASA
SPS subsystem review	Sacramento, California	March 18, 19	Bellamy, Simkin, Golstein, Field, Cadwell	S&ID, Aerojet
Mock-up review	Houston, Texas	March 18, 19	Karl, Gillmore	S&ID, Grumman, NASA
Service module propulsion	Clear Lake Site, Texas	March 18, 19	Maize, Merhoff	S&ID, NASA
Digital test command system subcontract	Minneapolis, Minnesota	March 18, 19	Schwarzmann, Indelicato, Graham, Behrens	S&ID, Control Data
Service propulsion system test coordination	Las Cruces, New Mexico	March 18 through 20	Milam, Kalbach	S&ID, NASA
Boilerplate 12 abort initiate single-point failure change coordination	Las Cruces, New Mexico	March 18 through 20	Proctor	S&ID, NASA
Earth landing system negotiation	Newbury Park, California	March 18 through 20	Beatty, Mispagel	S&ID, Northrop-Ventura
Technical interchange	Lowell, Massachusetts	March 18 through 20	Statham, McMurchy, Harthun	S&ID, Avco
AGC interface coordination	Cambridge, Massachusetts	March 18 through 20	Beck, Zeitlin, Silagyi, Witsmeer	S&ID, MIT
Boilerplate 13 interface control document coordination	Houston, Texas	March 18 through 24	Creek	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips March 16 to April 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Digital test command system program field analysis	Minneapolis, Minnesota	March 18 through 26	Wallace	S&ID, Control Data
Design review	Minneapolis, Minnesota	March 19 through 24	Fulton	S&ID, Honeywell
Program status review	Minneapolis, Minnesota	March 19 through 27	Gibson	S&ID, Honeywell
CSM stabilization and control subsystem design review	Minneapolis, Minnesota	March 20, 21	McCarthy, Devine, Watson, Mann, Mallon, Peterson	S&ID, Honeywell
Field operations coordination	Cocoa Beach, Florida	March 22	Pearce	S&ID, NASA
Final design review	Waltham, Massachusetts	March 22	Ford, Moen, Barmore, Lawler	S&ID, Space Sciences
Exhibit M finalization	Houston, Texas	March 22, 23	Drucker, Pearce	S&ID, NASA
Checkout work group special meeting	Cocoa Beach, Florida	March 22 through 25	McKown	S&ID, NASA
Command module emergency egress hatch mock-up review	Binghampton, New York	March 22 through 26	Erickson	S&ID, General Precision
Subsystem review	Tarrytown, New York	March 22 through 28	Field, Chen, Bankson, McKellar	S&ID, Simmonds
Management and quality control review	Phoenix, Arizona	March 23, 24	Ryan	S&ID, Motorola
Quality control problem review	Scotsdale, Arizona	March 23, 24	Hagelbert, Halverson, Ryan, Brandt	S&ID, Motorola
Site activation plan	Houston, Texas	March 23, 24	Lane	S&ID, NASA
Data station preliminary acceptance	Melbourne, Florida	March 23 through 26	Rutowski	S&ID, Radiation
Program effort review and evaluation	Middletown, Ohio	March 23 through 26	Confer, Eberhardt	S&ID, Aeronca
Engineering coordination	Huntsville, Alabama	March 23 through 27	Osbon, Paige	S&ID, NASA
Installation and checkout procedure modification	Las Cruces, New Mexico	March 23 through 28	Shaw	S&ID, NASA
Qualification test program	Elkton, Maryland	March 23 through 29	Yee, Babcock	S&ID, Thiokol
Meteoroid problem	Houston, Texas	March 24, 25	Oliver, Hendel	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips March 16 to April 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
LEM/CSM crew activity interfaces	Bethpage, New York	March 24 through 26	Shamis	S&ID, Grumman
Mock-up review	Bethpage, New York	March 24 through 26	Karl, Gillmore	S&ID, Grumman
Subcontract and hardware costs review	Newbury Park, California	March 24 through 27	Beatty, Jr.	S&ID, Northrop-Ventura
LEM common-use GSE coordination	Bethpage, New York	March 24 through 27	Hill	S&ID, Grumman
Monthly coordination meeting	Binghampton, New York	March 24 through 27	Hatchell, Kerr	S&ID, General Precision
Engineering support and review	Woodside, New York	March 24 through 27	Ross, Peterson	S&ID, Avien
Service propulsion subsystem test coordination	Las Cruces, New Mexico	March 24 through 27	Gallanes	S&ID, NASA
Boilerplate 12 test support	Las Cruces, New Mexico	March 24 through 27	Gillies	S&ID, NASA
Link coordination	Binghampton, New York	March 24 through 27	Frimtzis	S&ID, General Precision
Development test program review	Elkton, Maryland	March 24 through 27	Reilly, Babcock	S&ID, Thiokol
Facility test data review	Tullahoma, Tennessee	March 24 through 27	Hackett	S&ID, NASA
Project engineering coordination	Sacramento, California	March 24 through 27	Borde, Mower	S&ID, Aerojet
Engineering and design models material review	Woodside, New York	March 24 through 27	Peterson	S&ID, Avien
Design simplification meeting	Binghampton, New York	March 24 through 27	Matthews, Robertson, Leonard	S&ID, General Precision
Preflight field testing coordination	Las Cruces, New Mexico	March 24 through April 18	Brooks	S&ID, NASA
LEM project and scientific instrumentation studies	Bethpage, New York	March 25, 26	Clementson	S&ID, Grumman
Field operation coordination	Las Cruces, New Mexico	March 25, 26	Pearce	S&ID, NASA
Boilerplate 14 GSE status	Houston, Texas	March 25, 26	Rochester	S&ID, NASA
Checkout guidance and navigation systems meeting	Cocoa Beach, Florida	March 25 through 27	Sutherland	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
March 16 to April 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Model requirements	Hampton, Virginia	March 25 through 27	Biss, Scottoline	S&ID, NASA
Computer data and facilities review	Binghampton, New York	March 25 through 29	Matthews, Hill, Minick, Fairchild	S&ID, General Precision
Boilerplate 13 engineering support	Cocoa Beach, Florida	March 25 through April 11	Mohr	S&ID, NASA
Bench maintenance equipment and checkout methods review	Mountain View, California	March 26, 27	McNerney, Villifan	S&ID, Advance Technology
Perform aerodynamic testing	Mountain View, California	March 26 through April 10	Cameron	S&ID, NASA
Off-site activation planning	Las Cruces, New Mexico	March 27 through 31	Grey	S&ID, NASA
Vibration qualification test observation	Ann Arbor, Michigan	March 27 through April 4	Lindekugel	S&ID, Bendix
BME acceptance test meeting	Minneapolis, Minnesota	March 29	Pimple	S&ID, Honeywell
Acceptance test monitoring	Shawnee, Oklahoma	March 29	Brown	S&ID, Shawnee
Integrated system schematics coordination and review	Cocoa Beach, Florida	March 29 through April 4	Mattson	S&ID, NASA
Subminiature connector	Houston, Texas	March 30, 31	Fleck	S&ID, NASA
Launch umbilical tower and mobile arming tower utilization	Houston, Texas	March 30, 31	Samuelsen, Dunzer	S&ID, NASA
GSE customer interface problem coordination	Las Cruces, New Mexico	March 30, 31	Jones	S&ID, NASA
Design review	Rolling Meadows, Illinois	March 30 through April 1	Downes, Traver, Simonsen	S&ID, Elgin
Crew safety panel	Huntsville, Alabama	March 30 through April 1	Vucelic, Helms, Geheber	S&ID, NASA
Propellants and gases subpanel	Cocoa Beach, Florida	March 30 through April 2	Beede	S&ID, NASA
Reinstallation of loose components, assistance	Houston, Texas	March 30 through April 2	Smith	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
March 16 to April 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Design review requirements	Las Cruces, New Mexico	March 30 through April 2	Knoll	S&ID, NASA
Facilities requirements coordination	Houston, Texas	March 30 through April 2	Vrbancic	S&ID, NASA
Proposed supplemental agreement negotiations	Houston, Texas	March 30 through April 2	Webb	S&ID, NASA
Project engineering coordination	Sacramento, California	March 30 through April 3	Mower, Borde	S&ID, Aerojet
PACE breadboard test program coordination	Cocoa Beach, Florida	March 30 through April 4	Stott	S&ID, NASA
Specification changes	East Hartford, Connecticut	March 30 through April 5	Snyder, Thomas, Schaefer	S&ID, Pratt & Whitney
Perform aerodynamic testing	Mountain View, California	March 30 through April 10	Donovan	S&ID, NASA
Interface control document coordination	Cocoa Beach, Florida	March 30 through April 24	Ragusa	S&ID, NASA
Docking simulator acceptance test review	St. Louis, Missouri	March 31, April 1	Underwood	S&ID, McDonnell
Design review	Sacramento, California	March 31, April 1	Field, Cadwell, Few, Roznos, Witsmeer	S&ID, Aerojet
Wire and connector review	Houston, Texas	March 31, April 1	Johnson	S&ID, NASA
Launch escape motor program	Houston, Texas	March 31, April 1	Bellamy, Babcock	S&ID, NASA
Trajectory subpanel schedule of activities	Houston, Texas	March 31, April 1	Myers, Agajanian	S&ID, NASA
Block I and Block II change presentation	Houston, Texas	March 31 through April 2	Ryker, Walkover, Cole, Moore	S&ID, NASA
Crew systems division coordination	Houston, Texas	March 31 through April 2	Hair, Oliver, Boykin, Poage, Shea	S&ID, NASA
GSE coordination	Boulder, Colorado	March 31 through April 2	Alpert	S&ID, Beech

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S&ID Schedule of Apollo Meetings and Trips
March 16 to April 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Coordination	Bethpage, New York	March 31 through April 2	Neatherlin, Beckwith	S&ID, Grumman
Test data working group meeting	Houston, Texas	March 31 through April 3	Githens	S&ID, NASA
Engineering order and drawing release coordination	Las Cruces, New Mexico	March 31 through April 3	Kischer	S&ID, NASA
Current policy and procedures review	Cocoa Beach, Florida	March 31 through April 5	Highland	S&ID, NASA
Computer loading discussion	Houston, Texas	March 31 through April 10	Garing	S&ID, NASA
Revised cost report method coordination	Cedar Rapids, Iowa	March 31 through April 12	Beeman	S&ID, Collins
R&D antenna system	Houston, Texas	April 2	Bologna	S&ID, NASA
Heat shield instrumentation review	Houston, Texas	April 2	Barmore, Jones, Schurr	S&ID, NASA
GSE qualification testing	Houston, Texas	April 2	Furst, Rombach, Shelley, Stephens	S&ID, NASA
Program requirements coordination	WSMR, New Mexico	April 2, 3	Henderson	S&ID, NASA
SPS stability	Sacramento, California	April 2, 3	Beltran, Frankel	S&ID, Aerojet
SPS survey	WSMR, New Mexico	April 2, 3	Harlan	S&ID, NASA
Prequalification flight drop tests	El Centro, California	April 2 through 30	Weinrich, Young	S&ID, USN, NASA
Pressure suit analysis	Windsor Locks, Connecticut	April 3 through 7	Dziedzuila, Haky	S&ID, Hamilton Standard
IFTS design status review	Chicago, Illinois	April 3 through 10	Villafan	S&ID, IT&T-Kellogg
Maintenance training course	Framingham, Massachusetts	April 3 through May 3	Gregory	S&ID, Computer Control
S&ID/NASA technical management meeting	Houston, Texas	April 5	Cleworth, Drucker	S&ID, NASA
Coordination	Houston, Texas	April 5, 6	Benner	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
March 16 to April 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Automated systems briefing	Houston, Texas	April 5, 6	Fouts, Hogan, Levine, Shanahan	S&ID, NASA
Engineering coordination	Boulder, Colorado	April 5 through 7	Bouman	S&ID, Beech
Technical assistance	Pompano Beach, Florida	April 5 through 8	Hanchett, Hardaway	S&ID, Hoover
BME technical design review	Tarrytown, New York	April 5 through 8	Bankson	S&ID, Simmonds
PCM system design review	Metuchen, New Jersey	April 5 through 8	McFarland, Musso, Waskiewicz	S&ID, Applied Electronics
Communications requirements	Houston, Texas	April 5 through 8	Bakken, McCarthy, Page, Tyner, Van Meter, Wheelock	S&ID, NASA
Project engineering coordination	Sacramento, California	April 5 through 9	Borde	S&ID, Aerojet
Acceptance test observation	Shawnee, Oklahoma	April 5 through 15	Brown	S&ID, Shawnee
NASA/S&ID technical management meeting	Houston, Texas	April 6, 7	Gibb, Benner, Dodds, Mazur, Osbon, Petrey, Hershowitz	S&ID, NASA
Waste management system/SSA interface	Houston, Texas	April 6, 7	Mann, Paulsen, Scott, Staniec	S&ID, NASA
Schedule slip discussion	Cedar Rapids, Iowa	April 6 through 8	Hagelberg	S&ID, Collins
Contract discussion	Houston, Texas	April 6 through 8	Sparks, Jr.	S&ID, NASA
Audio center equipment design review	Cedar Rapids, Iowa	April 6 through 8	Dwinell, Lee	S&ID, Collins
Proposed GSE requirements	Houston, Texas	April 6 through 8	Chalker, Harkins, Jr., Hillberg	S&ID, NASA
Management and technical interchange meeting	Cedar Rapids, Iowa Lowell, Massachusetts	April 6 through 8	Halverson	S&ID, Collins, Avco
Production status review	Middletown, Ohio	April 6 through 8	Eberhardt	S&ID, Aeronca
Management meeting	Houston, Texas	April 6 through 8	White	S&ID, NASA
Boilerplate 12 specification coordination	WSMR, New Mexico	April 6 through 8	Gibson	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
March 16 to April 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Engine assembly design review	Sacramento, California	April 6 through 8	Cadwell, Field	S&ID, Aerojet
Tooling justification implementation	Indianapolis, Indiana	April 6 through 9	Westfall	S&ID, Allison
Monthly coordination meeting	Chicago, Illinois	April 6 through 10	Greenfield, King, Bartholomew, Pedigo, Villafan, Forrette, Abernathy, Blue	S&ID, ITT-Kellogg
Project engineering coordination	Sacramento, California	April 6 through 10	Mower	S&ID, Aerojet
BME coordination	Cedar Rapids, Iowa	April 6 through 10	Marine, Fish	S&ID, Collins
Acceptance test observation	Rolling Meadows, Illinois	April 6 through 11	Backman	S&ID, Elgin
Technical interchange	Lowell, Massachusetts	April 6 through 15	Monda	S&ID, Avco
Boilerplate 13 activities direction	Cocoa Beach, Florida	April 6 through 18	Hartzel	S&ID, NASA
Engine mount interference problem coordination	Sacramento, California	April 7 through 9	Carr	S&ID, Aerojet
Material and producibility approach review	Woodside, New York	April 7 through 9	Korb, Boehling	S&ID, Avien
Technical interchange	Lowell, Massachusetts	April 7 through 10	Morant, Kinsler, Statham, Howard, King, Hanifin, Johnson	S&ID, Avco
Engineering coordination	Minneapolis, Minnesota	April 7 through 10	Behrens, Schiff	S&ID, Control Data
Contract cost negotiations	Lowell, Massachusetts	April 7 through 17	Lowery, Stockwell	S&ID, Avco
Simulation digital computer presentation	Houston, Texas	April 8, 9	Benington	S&ID, NASA
Guidance and navigation system field operation discussion	Houston, Texas	April 8, 9	Zeitlin	S&ID, NASA
Site activation negotiations	Houston, Texas	April 8, 9	Webb	S&ID, NASA
Functional time flow schematics presentation	Bethpage, New York	April 8 through 10	Gerry, Anderson	S&ID, Grumman
Flight readiness requirements coordination	Cocoa Beach, Florida	April 8 through 10	Eslinger	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
March 16 to April 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Digital computer equipment for Apollo simulation	Houston, Texas	April 9	Barnett	S&ID, NASA
Real time abort control display	Houston, Texas	April 9, 10	Wiltse, Gillies	S&ID, NASA
Ordnance items	Houston, Texas	April 9, 10	Hitchens	S&ID, NASA
Communication and instrumentation panel meeting	Huntsville, Alabama	April 9 through 11	Chambers, Covington, Snook	S&ID, NASA
PERT problem resolution	Scottsdale, Arizona	April 11 through 17	Doll, Shear	S&ID, Motorla
Technical coordination and field analysis	Scottsdale, Arizona	April 12 through 16	Kolb	S&ID, Motorola
Specification change negotiation	Wilmington, Massachusetts	April 12 through 17	Peterson	S&ID, Avco
Off-site facilities inspection	Las Cruces, New Mexico	April 12 through 17	Parker	S&ID, NASA
Booster data	Huntsville, Alabama	April 12 through 17	Flatto, Kitakis	S&ID, NASA
BME acceptance test meeting	Minneapolis, Minnesota	April 12 through 19	Svegel	S&ID, Honeywell
Flight instrumentation discussion	Houston, Texas	April 13 through 15	Reed, Zeek	S&ID, NASA
Monthly engineering coordination meeting	Boulder, Colorado	April 13 through 15	Bouman, Waltz	S&ID, Beech
Airborne instrumentation and ACE test program	Houston, Texas	April 13 through 15	Reed, Jorgensen, Frey, Zeek	S&ID, NASA
Monthly coordination meeting	Boulder, Colorado	April 13 through 15	Pohlen	S&ID, Beech
SPS leakage and functional checkout support	White Sands, New Mexico	April 13 through 16	Milam	S&ID, NASA
Working group meeting	Houston, Texas	April 13 through 17	Myers	S&ID, NASA
Engine mount interference problem coordination	Sacramento, California	April 13 through 17	Carr, Mower, Borde	S&ID, Aerojet
Qualification test procedures	Minneapolis, Minnesota	April 13 through 17	Watson, Campbell, Johnston, Radeke	S&ID, Honeywell

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S&ID Schedule of Apollo Meetings and Trips March 16 to April 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Qualification test firing of tower jettison motor	Elkton, Maryland	April 13 through 19	Sumner	S&ID, Thiokol
Acceptance test meeting	Rolling Meadows, Illinois	April 13 through 19	Cason, Backman	S&ID, Elgin
Service module propellant dispersal system	Houston, Texas	April 14, 15	Sweet, Rooten, Nicholas	S&ID, NASA
AMS/IMCC working level meeting	Houston, Texas	April 14 through 17	Wright	S&ID, NASA
Schematic information coordination	Las Cruces, New Mexico	April 14 through 17	Sobek	S&ID, NASA
Ground power supplies	Cape Kennedy, Florida	April 14 through 17	McArthur, Quebedeaux, Neilson	S&ID, NASA
Honeywell program redirection review	Minneapolis, Minnesota	April 14 through 17	Maxwell, Valkenburg	S&ID, Honeywell
Little Joe II configuration and resistance	San Diego, California	April 15	Neudorfer	S&ID, General Dynamics
ASPO Systems Engineering Block II briefing	Houston, Texas	April 15, 16	Ryker	S&ID, NASA
Connector and wire presentation	Houston, Texas	April 15, 16	Groharing, Johnson	S&ID, NASA
SPS test fixture F-2 status review	White Sands, New Mexico	April 15, 16	Field, Gallanes	S&ID, NASA
Engineering change coordination	Scottsdale, Arizona	April 15, 16	D'Ausilio, Werner	S&ID, Motorola
SRI food subcontract	Houston, Texas	April 15 through 17	Osborne	S&ID, NASA
Control interface and checkout of analog computer	Denver, Colorado	April 15 through 17	Crunkleton, Bruhn	S&ID, Comcor
Test fixture 2 and airframe 001 coordination	Las Cruces, New Mexico	April 15 through 17	Bergeron	S&ID, WSMR
Unmanned spacecraft missions	Houston, Texas	April 15 through 19	Kellett, Shanahan, Steinwachs, Perkins	S&ID, NASA

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